OFFSHORE HYDROCARBON EXPLORATION DRILLING OPERATIONS IN THE SOFALA CONCESSION AREA, SOFALA AND INHAMBANE PROVINCES, MOZAMBIQUE

ENVIRONMENTAL IMPACT ASSESSMENT REPORT
FINAL REPORT

Prepared for
Sasol Petroleum Sengala Limitada

Maputo
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This document is also available in Portuguese

NON-TECHNICAL SUMMARY

INTRODUCTION

Sasol Petroleum M-10 Limitada and Sasol Petroleum Sengala Limitada (hereafter referred to as SPM-10 Limitada and SPSL, respectively), is planning to conduct Offshore Exploration drilling in the M-10 and Sofala Concessions off the coastline of Sofala Province, Mozambique. Licences for the offshore exploration were issued by the National Petroleum Institute (INP), effective from 1 February 2010. As part of the Exploration Production Concession Contract (EPCC), SPM-10 and SPSL have committed to drill at least one well in each concession before the end of the second exploration period on 31 January 2011, and does not expect to drill more than two sites per concession within this exploration period. Additional wells would require an addendum to this EIR and approval from MICOA. Location of the concession areas and approximate positions of the proposed wells are shown in *Figure 1*

An Environmental Impact Assessment (EIA) is required to evaluate the potential environmental effects of the planned drilling programme; to identify and recommend measures to mitigate potentially harmful effects of the operation, and to compile an Environmental Management Plan. SPSL appointed Impacto, Projectos e Estudos Ambientais Lda, in partnership with Environmental Resources Management Southern Africa (Pty) Ltd. (ERM) to undertake the required EIA in accordance with Mozambican legislation and World Bank/International Finance Corporation (IFC) guidelines.

The EIA process for the two concessions has been carried out simultaneously, but separate reports are required. This summarises the project and EIA findings of proposed drilling in the Sofala Concession.

SCOPE OF THIS EIA

The evaluation of impacts presented in this report covers exploration well drilling and well testing at a maximum of two provisionally identified sites shown in *Figure* or at an alternative location in the concession within 10 km of the shallow water prawn fishery. This distance was determined based on the worst-case scenario of potential turbidity and biochemical impacts on the prawn fishery. Dispersion modelling at the current sites has indicated a potential cuttings settlement zone of 4.67 km^2 (equivalent to a maximum of 1.2 km from the drill site), while turbidity plume modelling for the shallow water environment near Bazaruto predicted elevated turbidity over a 5 km radius from the well site (ERM & Consultec 2008). To allow for potentially higher silt content in the sediments of Sofala Bay (due to the higher silt laden inflows from major rivers: Pungue, Save and Buzi), and for potential noise effects, we have allowed for a 10 km buffer zone from the fishing areas within which turbidity levels are expected to drop to normal ambient levels. If revised drill site positions are identified within the 10 km buffer zone or if additional wells are required, additional investigation and discussion with fishing stakeholders will be needed, and which will require an addendum to this EIA for approval by MICOA.

LEGAL FRAMEWORK

Oil and gas industry activities in Mozambique are regulated by the National Petroleum Institute (INP). The Ministry for the Coordination of Environmental Affairs (MICOA) is required to review EIAs and issue an Environmental License; to advise the INP on the acceptability of proposed oil and gas development activities, and to conduct inspections and audit development activities. Other institutions involved in maritime safety-related activities are the National Maritime Institute and to a lesser extent and responsible mainly for navigational aids, the National Hydrography and Navigational Institute (INAHINA).

The Environmental Law No. 20 of 1997 requires that an EIA, including public consultation, is undertaken for all activities that can have an impact on the environment and society.

The Decree on Regulations for Petroleum Operations No. 24 of 2004 deals specifically with activities related to the petroleum industry.

The Decree on Environmental Impact Assessment Process No. 45 of 2004 establishes a set of procedures to be followed when carrying out an EIA and compiling an Environmental Impact Statement (EIS).

Key Mozambican legislation relevant to the project includes:

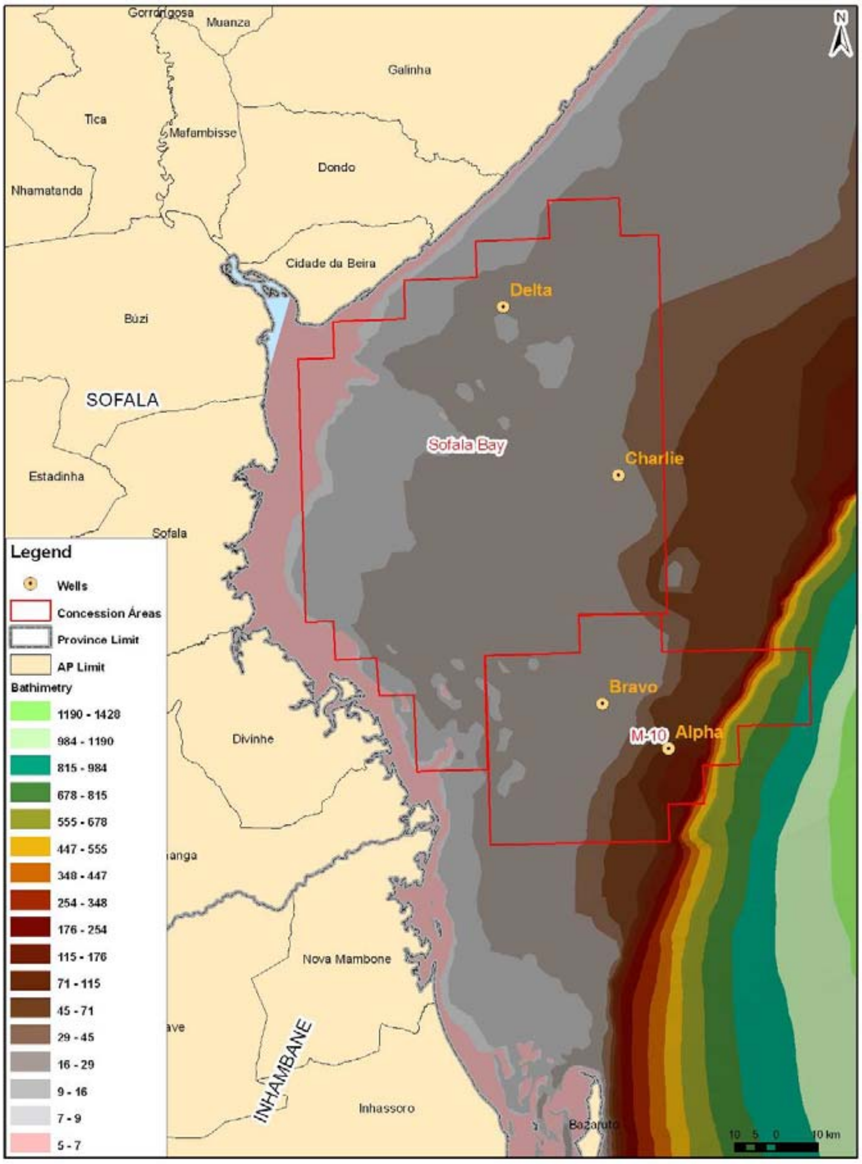
- Regulation for Petroleum Operations: Decree No.24 of 2004.
- Regulations on EIA Process: Decree No. 45 of 2004
- General Directives for EIA: Ministerial Diploma No. 129 of 2006
- Regulations for the Prevention and Protection of the Marine and Coastal Environment

Key international conventions to which Mozambique is a signatory include the International Convention for the Prevention of Pollution from Ships 73/78 (MARPOL), the International Convention on the Prevention of Marine

Pollution by Dumping of Wastes and other Matter (London Convention), and the United Nations Convention on Law of the Sea 1982 (UNCLOS).

A full description of legislation relevant to the oil and gas industry in the offshore environment is given in Chapter 3 and *Annex D*.

Figure 1 Map Showing Location of Sofala and M-10 Blocks in Relation to Bathymetry



PROJECT DESCRIPTION

Two exploration wells (Charlie and Delta) are proposed for drilling in the Sofala Concession, located in Sofala Bay in Mozambique, situated approximately 73 km and 23 km southeast of the coastline north of Beira. Water depths at the well sites are approximately 20 m at the Delta well and 30 m at the Charlie well.

The wells would be drilled using a jack up rig and rotary drilling. A Water-Based Drilling Fluid (WBDF) would be used for the top sections of the wells and a Group III Non-Aqueous Drilling Fluid (NADF) for the bottom sections due to the expected high percentage of clay minerals which would reduce well performance. The precise content of the Group III NADF will be confirmed prior to drilling. Cuttings drilled with WBDF would be discharged at the sea floor, while cuttings from the middle and lower sections drilled with NADF would be treated to a maximum oil content of 5% and discharged three to five metres below the sea surface. Retrieved and unused NADF would be returned to suppliers for recycling or appropriate disposal

A 500 m exclusion zone will be maintained around the drilling rig while on location. Two supply vessels will transport supplies and waste material between the drilling unit and the Port of Beira, which will serve as the logistic support base for the operation. Approximately 80-100 skilled personnel will be employed on the rig and for other support services and will be accommodated in hotels in Beira on a rotational basis. Apart from hotel accommodation and services for personnel, supplies of water, fuel and food will be sourced from service providers in Beira.

Drilling of each well is expected to take 40-45 days followed by 10-15 days of well testing, involving flaring of hydrocarbons.

AFFECTED ENVIRONMENT

A description of the affected environment is required to place the environment of the concession in a regional perspective as a basis for predicting and assessing potential impacts arising from the drilling operations. The relevant natural biophysical and socio-economic environment between Bazaruto Archipelago to the south and Beira to the north of the concession, and extending seawards encompassing the entire Sofala and M-10 Concession areas, are relevant to the proposed operations and potential impacts.

Central Mozambique has a warm and moist tropical climate with predominantly south-easterly winds in the Beira area averaging 12.7 km/h.

The area is at relatively high risk of cyclones during the November to March period, ranging from moderate to intense tropical storms, and which can cause significant coastal damage. The concession lies on the broad gently sloping muddy-sandy continental shelf, which averages a depth of 20 m, but where the drill sites are located at the shelf edge in 50-100 m. The shelf waters are influenced by currents and tides. Surface currents flow predominantly southward throughout the year caused by the south-easterly wind, and averages 0.6 m/s with slightly stronger currents from November to April, attaining 2 m/s. Inshore counter-currents also occur and are highly variable in speed and direction but are predominantly northwards, consistent with the wave climate. Tidal amplitude in Sofala Bay is the highest in the country due to the extensive continental platform and averages 6.4 m near Beira. Sofala Bay is subject to relatively high sediment transport and turbidity particularly in the rain and flood seasons due to the large inflows from the Pungue, Buzi and Save Rivers, and exacerbated by the long-shore currents and high tidal amplitude across the shallow wide shelf.

Plankton blooms occur frequently in Sofala Bay and are generated by a combination of wave action over shallow sediments and recycling of seabed nutrients, combined with inflow of nutrients from the river estuaries and extensive mangroves along the coast. Peaks of plankton production is often associated with peak freshwater inflows near the Govuro, Save, Buzi and Pungue River mouths, although high sediment loads influences primary production levels. Variations in salinity levels related to flushing of river mouths and flood releases also influences distributions of icthyoplankton distribution and abundance, which sustain the commercial fisheries.

Benthic fauna in the study area is not well known but is predicted to be fairly homogenous in terms of species distribution with greater diversity and abundance in shallower areas. It is unlikely to be especially distinct from other areas of the Mozambican coastline or to have unique assemblage. The key benthic species of interest are various species of prawns, which support the economically significant prawn fishery of Sofala Bank. Adult and post-larvae prawns live in the muddy/sandy sediments of the seabed, usually in the 20-50 m depth zone (although some occur in deeper water to 90 m) where they feed on plankton and detritus, and lay eggs. Juveniles migrate into estuaries where they mature and return to the sea. The connection between river estuaries and the sea, and river outflow, is a critical component of their life-cycle, and therefore in supporting the commercial fishery for these species. Octopus and cuttlefish species also occur with the Indian Squid occurring east of the 20 m depth contour.

The important groups of fish that occur in the area are those that support the industrial, semi-industrial and artisanal fisheries, namely pelagic and demersal fish and crustaceans (prawns, shrimps and crabs). Fish diversity is high with 97 demersal fish and 16 pelagic species, of which only eight species are common. Several fish are important recreational fish, including marlin, sailfish, wahoo, dorado, kingfish and king mackerel although no recreational fishing is known to occur in the concession areas.

Whales and dolphins occur throughout the region with five dolphin species and seven whale species confirmed as present, but with most records from Bazaruto Archipelago National Park (BANP). Of these, the humpback dolphin is near threatened, and is generally sighted over shallow sandy substrate near the islands, and sperm whales, listed as vulnerable which generally occur in deep offshore waters. The dugong, a long lived aquatic mammal with low birth rate and listed as Vulnerable to Extinction, inhabits the sea grass areas of BANP and has been recorded 10 km offshore the Save River Estuary but is not known north of here. Five endangered turtle species have been recorded in Mozambican coastal waters of the Sofala Bay area, four of which may nest on the sandy beaches between October and February, with hatchlings found between January and April. All species of seabirds likely to occur offshore Mozambique have wide distributions in the south-eastern Atlantic and western Indian Oceans.

The coastline of Sofala Bay is largely characterized by extensive mangrove forests which form an almost continuous fringe along the coast, and which play a crucial role in nutrient turnover and enrichment and supporting high biodiversity. These are intersected by stretches of rocky shore and sandy beach. Coral reefs and sea grass meadows occur in several localities in the BANP but the high turbidity in Sofala Bay likely precludes their occurrence here. These habitats provide refuge and support high biodiversity and contribute to the uniqueness of the BANP.

BANP is the only protected area, situated at least 60 km to the south of the southern boundary of the Sofala Concession, and which has high conservation and international tourism status for its marine and coastal attractions, centred on fishing, coral reefs and tropical sandy beaches. The Marromeu Reserve lies to the north of Beira and is a RAMSAR site for its population of wetland birds, including supporting three to four of the world's population of Wattled Crane.

Human settlement is concentrated in Beira, which is the region's largest city and port, and is a major regional growth centre receiving freight bound for countries inland (Republic of Malawi and Zimbabwe), and fishing vessels. Dredging of the entrance channel to the port is expected to substantially improve economic opportunities for the port and city of Beira, and Beira corridor. While most of the population of the broader project area are concentrated in Beira District, a number of settlements occur along the coast, the inhabitants of which are largely dependent on fishing, and to a lesser extent agriculture, for their livelihoods. Fishing is the mainstay of the local rural population and the Sofala Bank fishery, and is valued at 80 million dollars per year or three percent of Gross Domestic Product (GDP).

The shallow water prawn fishery comprises three types of operators: multi-national operators owning half the fishing quota; individual foreign and domestic industrial fishing operators, and traditional small scale (artisanal) fishers. The artisanal fishery generally operates within 3 km of the shore; the semi-industrial fishery from the Save River to north of Beira and overlapping half of the Sofala Concession; the industrial shrimp trawl fishery north of the Sofala Concession, and the industrial deep water shrimp fishery at least 30 km to the east of the Sofala Concession.

Artisanal fishers fish from an estimated 116 fishing centres along the Sofala coast and 79 in Inhambane with the majority in Machanga and Buzi. An estimated 80,000 registered artisanal fishermen operate in Sofala Bank with and without vessels. In 2007, census data indicated an estimated 4673 fishing vessels in districts near the project area (Dondo, Beira, Buzi, Machanga and Govuro) involving approximately 12,000 fishers. Most of the artisanal catch is caught in the five districts closest to the concession area, estimated at 14,505 tons in 2009. The prawn fishery operates for six to nine months of the year, with the peak period from March to May and a two month closed season generally in January-February. In 2009, the semi-industrial fishery involved 62 vessels while the industrial fishery involved a total of 237 vessels: 58 for shrimp; 16 for deep water shrimp; 18 for line fish; and 166 for tuna (to the north of Sofala Bank).

Other coastal projects include a large aquaculture project, occupying 500 ha, located 15 km northeast of Beira at the Maria River (and 15 km north of the closest Sofala Concession boundary), and ten salt pans in the coastal areas of Govuru and Machanga Districts.

Tourism along the coast in Sofala Bay is limited, as indicated by the paucity of accommodation establishments, and is attributed to the lack of good swimming beaches and coral reefs due to the high turbidity; significant wave height differential between low and high tides, and extensive covering of mangrove forests. Most tourism is concentrated on the Bazaruto Archipelago and Vilanculos area, located to the south, which attracts significant tourism investment in up-market tourism centred on the marine attractions.

IMPACT ASSESSMENT

Impact assessment methodology

Potential impacts are assigned a significance rating based on an overall rating of magnitude (which is derived from a standard set of criteria, including extent or area of the impact, impact duration, and intensity), and probability or likelihood. Magnitude and Probability are used to derive the significance rating of negligible, low, moderate or high. The methodology is described in Chapter 2.

Potential Impacts of Exploration Drilling

A summary of the potential impacts of the proposed exploration well drilling in the Sofala Concession is presented in *Table* and *Table 2.* Note that the significance ratings are assigned assuming compliance with standard international best practice and adherence to legislative requirements (here termed 'embedded' mitigation), and with additional mitigation measures identified during the course of the EIA that are predicted to ameliorate the magnitude of the impact but not necessarily change the significance of the impact.

The following impacts and their significance are predicted:

- The potential impact of positioning the drilling vessel on benthic fauna and other marine biota is predicted to be of *negligible* significance.

- The potential impacts of vessel and helicopter movements, and noise, lighting and flaring from the drilling rig during drilling and well-testing operations on cetaceans (whales and dolphins), fish, squid and seabirds would be of *negligible significance* with the implementation of the recommended mitigation measures.

- The discharge of drill cuttings with residues of NADFs may impact the marine and benthic environment through smothering effects, modification of benthic habitat and toxicity effects but these are predicted to be of *negligible* significance if cuttings are treated and dried to reduce oil content to five percent by weight.

- The potential pollution impacts as a result of routine operational emissions, discharges and waste disposal at sea are assessed to be of *negligible* significance, as long as the relevant local and international regulations are adhered to, particularly MARPOL standards.

- Onshore disposal of solid waste would be of *negligible* significance as long as all waste, particularly hazardous waste (such as spent oil, batteries, used chemicals, medical waste etc) is segregated and disposed of at suitable waste disposal facilities.

- Potential impacts on artisanal and industrial fishing activities as a result of the 500 m exclusion zone around the drill rig and due to the plume and settlement of drill cuttings is predicted to be of *negligible* significance. While high value fishing activities occur in the shallow inshore areas and deeper water offshore, no fishing activities are known to take place within the vicinity of the proposed drill sites. This assessment applies to drilling one or two wells within 10 km of the semi-industrial prawn fishing area to accommodate any shift in well position. Should new well sites be selected within the 10km buffer zone or in the shallow water fishing area then additional investigations and a possible addendum to this EIA drilling will be required.

- Impacts on tourism is predicted to be of *negligible* significance as little tourism takes place in Sofala Bay which could be affected by the drilling rig and support operations, which would be located at least 23 km from shore, while the high value tourist area of Bazaruto also occurs at least 60 km to the south (from the southern boundary of the concession).

- Potential navigational hazard posed by the drill rig and the operation of support vessels that may affect other vessels is predicted to be of *negligible* significance if standard maritime communications are adhered to.

- The potential impacts of a highly unlikely accidental release (spill) of hydrocarbons on mangroves, estuaries, lagoons and the coastal conservation area of Bazaruto National Park could be of *major* significance. Implementation of high technical safety standards and precautions throughout the drilling project would reduce the risk to exceedingly low levels.

The only residual impacts likely to remain after the 120-day drilling activities are complete are predicted to be:

- Deposition of drill cuttings and residues of Non-Aqueous Drilling Fluids (at maximum 5 % oil content) across an estimated area of 4.67 km^2, with a thickness of less than 2 mm across most of the depositional area. Mounding can be expected in the immediate vicinity of the drill site. Some alteration of the benthic fauna community, possibly some loss of sensitive species such as crustaceans, and change in benthic habitat (eg sediment grain size profile) can be expected near the well for a period of one to three years after drilling. The seabed is likely to recover relatively quickly due to colonization of the affected area by adjacent benthic species and facilitated by the prevailing currents and tidal regime.

- The possible presence of one or two suspended well heads on the sea floor for an indefinite period, which will require a 500 m exclusion zone to be retained. No trawling or other fishing activities can take place within this zone but this is not a significant impact as no trawling currently takes place in the vicinity of the drill sites.

MITIGATION MEASURES

Key recommended mitigation measures include:

1. Inform other users of the sea about the timing and location of drilling activities in accordance with a Communications Plan.

2. All helicopters to adhere to direct flight paths, maintain an in-transit flying height of 500 m and to avoid detours over sensitive areas.

3. All supply vessels to look out for cetaceans (whales and dolphins) and turtles and to avoid approaching these animals within 350 m.

4. Ensure full compliance with MARPOL regulations regarding emissions, discharges and waste disposal at sea, including maintenance of all equipment to minimise noise and emissions.

5. Ensure efficient treatment of cuttings generated with Non Aqueous Drilling Fluids (NADFs) to reduce oil content to five percent on average, and select appropriate discharge depth of at least 3-5 m below sea surface to aid dispersion.

6. Compile and implement a Waste Management Plan detailing procedures from storage, handling, inventories, tracking and disposal.

7. Compile and implement an Emergency Response Plan, including procedures in the event of a cyclone.

8. Compile an Oil Spill Contingency Plan with input of other stakeholders, and in alignment with the NOSCP, and ensure appropriate informed response in the event of a spill.

Table 1. Summary of Well Drilling and Well Testing Impacts

Cause & Nature of Impact	Potential Negative Impact	Assessment of Impacts								
		Magnitude Criteria								Confidence
		Extent	Duration	Intensity	Magnitude	Likelihood	Significance (embedded mitigation)	Mitigation (in brief)	Significance (additional mitigation)	
Rig positioning on sea bed	Physical damage to benthic fauna and turbidity effects on water column biota	Site (localised effect at drill rig location)	Short-term (120-day drilling period)	Low (benthic fauna widely distributed and will recolonise)	Low	Definite	**MINOR**	Scan seabed to verify absence of sensitive habitats and remove left or dropped objects	**NEGLIGIBLE**	High
Lighting and flaring from the rig	Lights and flaring may attract sea birds and other marine fauna that may be injured or killed.	Site (drill rig location)	Short-term (120-day drilling period)	Low (low species numbers affected)	Low	Likely	**MINOR**	Shield or reduce lights to limit range of illumination. Collect disoriented birds and release.	**NEGLIGIBLE**	High
Helicopter and service vessels: noise and vibration	Noise and presence close to sensitive species may disturb marine fauna eg whales	Regional (Beira – Sofala Bay area)	Short-term (120-day drilling period)	Low (transient impact)	Low	Likely	**MINOR**	Helicopters to adhere to flight paths and maintain 500m height in transit. Service vessels to maintain 350m distance from cetaceans.	**NEGLIGIBLE**	High
Noise from drilling	Noise may disturb marine fauna eg whales, turtles etc	Local (within 10 km range)	Short-term (120-day drilling period)	Low (noise levels similar to ships in transit)	Low	Likely	**MINOR**	Check for marine mammals before undertaking very noisy activities and landing helicopters. Maintain equipment.	**NEGLIGIBLE**	High

Cause & Nature of Impact	Potential Negative Impact	Assessment of Impacts								
		Magnitude Criteria								Confidence
		Extent	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance (embedded mitigation)**	**Mitigation (in brief)**	**Significance (additional mitigation)**	
Release to sea of drill cuttings with residues of drill fluids	Settlement of drill cuttings may smother benthic fauna	Local (close vicinity to drill site)	Short-term (120-day drilling period)	Low (deposition predicted to be <2mm thick over most of settlement area)	Low	Definite	**MINOR***	Release cuttings from deeper sections 3-5 m below sea level to aid dispersion	**NEGLIGIBLE**	High
	Increased turbidity may adversely affect water column fauna eg plankton	Local (maximum of 5-10 km around rig)	Short-term (120-day drilling period)	Low (ambient turbidity high at times and majority of cuttings will settle quickly)	Low	Likely	**MINOR***	Release cuttings from deeper sections 3-5 m below sea level to aid dispersion	**NEGLIGIBLE**	High
	Contamination effects on marine life	Local (maximum of 5-10 km around rig)	Medium-term (1-3 years to recover)	Low (depositional area maximum 2mm thick and rapid bio-degradation expected)	Low	Likely	**MINOR***	Use low toxicity biodegradeable drilling fluids (eg. Group III Non-Aqueous Drilling Fluid)	**NEGLIGIBLE**	High
Gaseous emissions from flaring & generators	Increased air pollution on atmosphere	Local (within 500 m of rig)	Short-term (120-day drilling period)	Low (minor quantities of gases)	Low	Likely	**MINOR**	Regular maintenance of equipment, generators and flare burners to burn at high efficiency	**NEGLIGIBLE**	High

Cause & Nature of Impact	Potential Negative Impact	Assessment of Impacts								
		Magnitude Criteria								Confidence
		Extent	Duration	Intensity	Magnitude	Likelihood	Significance (embedded mitigation)	Mitigation (in brief)	Significance (additional mitigation)	
Release of contaminated deck drainage & machinery and ballast water	Oily water can contaminate marine environment	Local (vicinity of drill vessel; 500 m radius)	Short-term (120-day drilling period)	Low (minor amounts of oily polluted water will disperse and dilute rapidly)	Low	Likely	**MINOR***	Comply with MARPOL standards: Machinery space 15mg/l Other effluents <40 mg/l (monthly average) Other effluents <100mg/l (instantaneous limit)	**NEGLIGIBLE**	High
Sewage and galley waste discharges to sea	Increased disposal of organic matter to sea increased bacterial loading and biological oxygen demand	Local (vicinity of drill vessel)	Short-term (120-day drilling period)	Low (organic waste will be quickly degraded and dispersed)	Low	Likely	**MINOR***	Comply with MARPOL standards: Macerate organic food to <25mm size and discharge beyond 3 nautical miles of shore; Macerate sewage and discharge beyond 12 nautical miles or macerate and treat sewage and discharge beyond 3 nautical miles.	**NEGLIGIBLE**	High
Production of garbage and solid waste	Disposal to sea of certain wastes will pollute marine environment	Local (vicinity of drill vessel or end location)	Short-term (120-day drilling period)	Low (isolated / accidental waste items only)	Low	Likely	**MINOR**	Comply with MARPOL standards and Waste Management Plan (to be produced prior to drilling): No plastic to be disposed of to sea. Segregate and recycle waste and dispose onshore to appropriate facilities.	**NEGLIGIBLE**	High

Cause & Nature of Impact	Potential Negative Impact	Assessment of Impacts								
		Magnitude Criteria								Confidence
		Extent	Duration	Intensity	Magnitude	Likelihood	Significance (embedded mitigation)	Mitigation (in brief)	Significance (additional mitigation)	
Rig has 500m exclusion zone and drill cuttings may affect fish & prawn populations	Interference with artisanal and industrial fishing through loss of access or disturbance of fish/prawn stocks	Local (maximum 5-10 km of rig due to turbidity plume)	Short-term (120-day drilling period)	Low (drill cuttings will disperse rapidly and	Low	Likely	**MINOR**	Use Group III NADP to minimise risk of biochemical impacts. Discharge drill cutting 3-5 m below sea surface.	**NEGLIGIBLE**	High
Presence of the drilling vessel creates a visual impact	Visual and perceived loss of sense of place on tourism	Regional (visibility from other users in Sofala Bay)	Short-term (120-day drilling period)	Low (drilling vessel at least. 23 km from shore and >80 km from main tourist area of Bazaruto)	Low	Unlikely	**NEGLIGIBLE**	Keep stakeholders informed of drilling activities.	**NEGLIGIBLE**	High
Presence of drilling vessel and operation of support vessels creates a navigational impact	500 m exclusion zone and regular transit of support vessels may interfere with passage of vessels and pose navigational risk	Regional (Sofala Bay marine users)	Short-term (120-day drilling period)	Low (marine traffic entering and leaving Beira and likely to be affected is low)	Low	Likely	**MINOR**	Inform fishing and shipping representatives of drilling rig location and support vessel activities. Notify marine users with standard navigational measures. Maintain communication aids and ensure look out on bridge at all times.	**MINOR**	High

Cause & Nature of Impact	Potential Negative Impact	Assessment of Impacts								
		Magnitude Criteria								Confidence
		Extent	Duration	Intensity	Magnitude	Likelihood	Significance (embedded mitigation)	Mitigation (in brief)	Significance (additional mitigation)	
Drilling will disturb sea bed and potential shipwrecks	Unknown shipwrecks could be affected by drilling	Site (drilling site)	Permanent (if ship-wreck affected)	Low (side scan surveys prior to drilling may detect presence)	Low	Unlikely	**NEGLIGIBLE**	Undertake sea bed survey with side scan sonar prior to drilling. Alert INAMAR if shipwreck found.	**NEGLIGIBLE**	Moderate
Wellheads may be suspended on sea floor for future use	Suspended well heads with 500m exclusion zone will preclude trawling	Site (500 m exclusion zone	Long-term (depends on time until abandoned)	Low (no trawling takes place in the area of the drill sites)	Low	Unlikely	**MINOR**	Mark location of suspended wellheads on Notice to Mariners and inform fishing stakeholders.	**MINOR**	High
Increased presence of foreign workers in Beira	Increased health risks associated with HIV/AIDS and STDs and impacts on social cohesion	Local (Beira)	Short-term	Low	Low	Likely	**MINOR**	Education and awareness risk of HIV/AIDS and STDs through sexually inappropriate behaviour. Provision of condoms to staff.	**NEGLIGIBLE**	High
Increased expenditure in Beira	Purchase of goods and services in Beira by project staff will have economic benefits	Local (Beira)	Short-term	Low	Low	Likely	**MINOR**	SPSL should invite and consider tenders from local suppliers and consider all tenders in a fair and transparent manner	**MINOR**	High

* Assumes mitigation measures are embedded and complied with.

Table 2. Summary of Impacts in the Event of Major Oil Spill Event (eg. well blow out or vessel collision)

Cause & Nature of Impact	Potential Negative Impact	Assessment of Impacts								
		Magnitude Criteria								Confidence
		Extent	Duration	Intensity	Magnitude	Likelihood	Significance (embedded mitigation)	Mitigation (in brief)	Significance (additional mitigation)	
Worst Case Oil Spill Event	Damage / loss of sensitive marine and coastal habitats and species	Regional to International (Bazaruto is a National Park)	Long-term	High (depends on type and amount of oil spilled, and prevailing conditions)	High	Likely (likely to occur in the improbable event of a major spill)	**MAJOR**	Compliance with National Oil Spill Contingency Plan (NOSCP) and SPSL developed Oil Spill Response Plan.	**MODERATE**	Moderate - High
	Oil pollution of the marine environment could impact tourism at Bazaruto & Sofala Bay	Regional to International (Bazaruto is a prime international tourist destination)	Medium (depends on success of clean up actions	High (depends on type and amount of oil spilled, timing of spill and prevailing conditions)	High	Likely (likely to occur in the improbable event of a major spill)	**MAJOR**		**MODERATE**	Moderate
	Reduced fish / prawn catches by artisanal fishers; reduce livelihoods, and oil fishing equipment	Regional - International (Sofala Bank fishery is major export fishery)	Medium	High (especially if oil spill occurs in peak prawn spawning or catching season)	High	Likely (likely to occur in the improbable event of a major spill)	**MAJOR**		**MODERATE**	Moderate
	Reduced fish / prawn catches by industrial fishers, and oiling of equipment, causing loss of livelihood	Regional - International (Sofala Bank fishery is major export fishery)	Medium	High (especially if oil spill occurs in peak prawn spawning or catching season)	High	Likely (likely to occur in the improbable event of a major spill)	**MAJOR**		**MODERATE**	Moderate

ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (EMP) is a framework for implementation of the aforementioned types of mitigation measures, including frequency, timing and responsibility. The EMP specifies mitigation measures required to reduce the extent and severity of potential impacts, and indicates additional plans that are required to be in place prior to the onset of drilling, such as plans for Waste Management, Emergency Response, and Oil Spill Contingency. These plans are the responsibility of Sasol and its identified contractor, in compliance with relevant legislation.

Adherence to the EMP and the identified mitigation measures is predicted to minimise the environmental impact of the drilling project to a minor level with no residual or lasting observable impact on the receiving environment within one to three years. The longest legacy effect may be the impact of drill cutting deposition on 4.67 km^2 of seabed, which may alter the benthic fauna composition within this localised area, particularly in the vicinity of the drilling rig for a period of one to three years. Another residual impact is the possibility of leaving one or two suspended well heads on the sea floor, which will require a 500 m exclusion zone for trawling until it is removed.

CONCLUSIONS

The majority of the impacts of the proposed exploration well drilling activities during normal operations are assessed to be of minor or negligible significance with implementation of the recommended mitigation measures.

The drilling operation is not expected to contribute significantly to the cumulative impacts of the offshore oil and gas industry in Mozambique. Sasol proposes to drill only two wells in each of the M-10 and Sofala Concessions with the total cuttings depositional area modelled at 6.4 km^2 in M-10 and 4.76 km^2 in Sofala, and neither overlapping with another.

The most serious impact of drilling is the associated risks posed by an oil spill arising from a well blow-out or collisions resulting in a large hydrocarbon spill. With responsible management of activities in accordance with the environmental management plan presented in this report (including compliance with the relevant international and Mozambican regulations), and subsidiary plans (eg waste management plan, Oil Spill Contingency Plan and Emergency Response Plan), the proposed exploration well drilling activities poses minimal threat of serious or irreversible damage to the environment. Upset conditions, such as a major oil spill, may cause irreversible damage to biodiversity and livelihoods in the affected area, but are extremely unlikely to occur.

Section 1:

Introduction

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1 INTRODUCTION

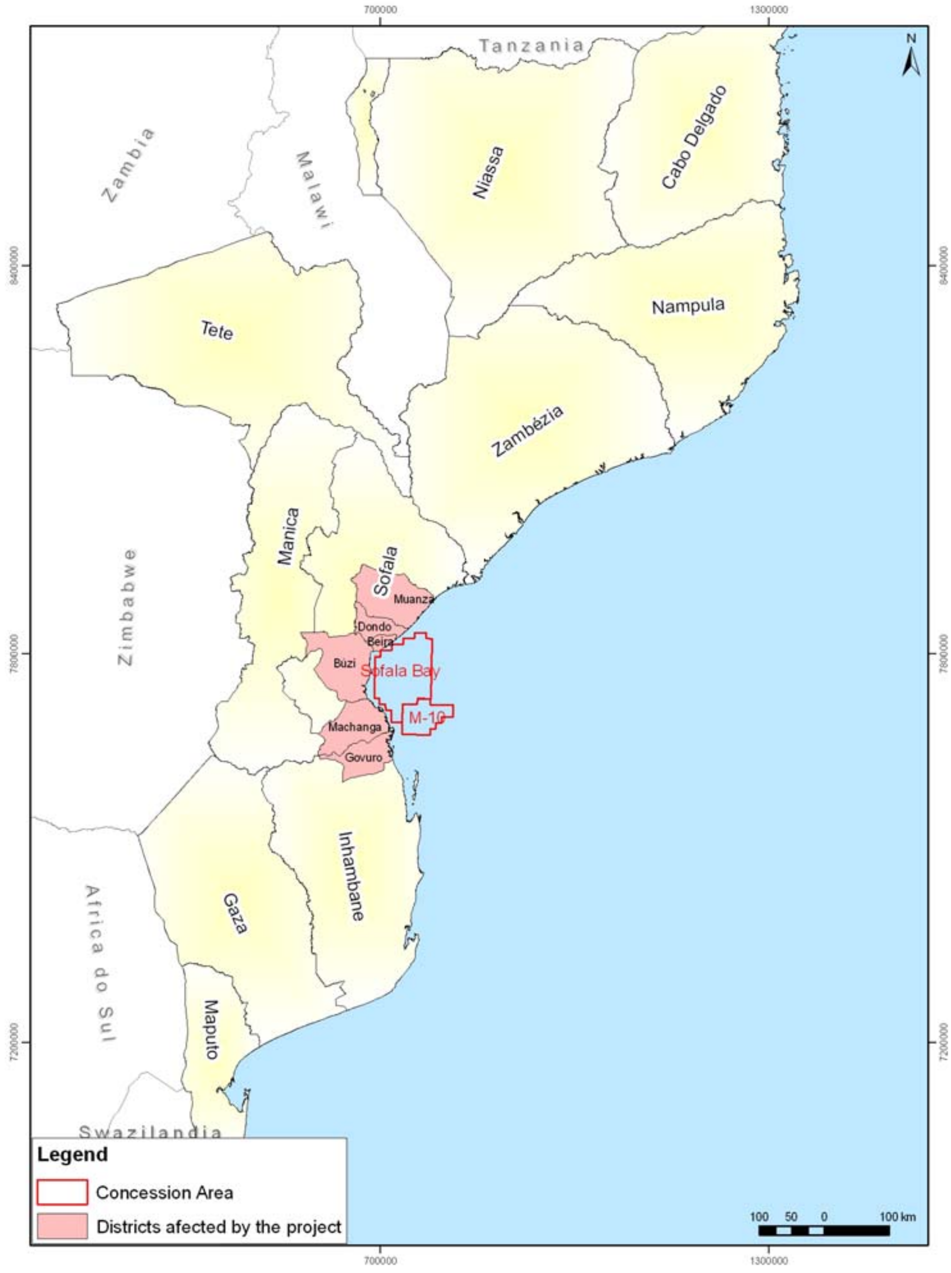
1.1 PURPOSE OF THIS ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Sasol Petroleum M-10 Limitada (Exploration Production Concession Contract M-10) and Sasol Petroleum Sengala Limitada (Exploration Production Concession Contract Sofala) (hereafter referred to as SPM-10 and SPSL, respectively) are planning to conduct Offshore Exploration Drilling Activities in the M-10 and Sofala Concessions, offshore the coastline of Sofala Province, central Mozambique (see *Figure 1.1*). The Environmental Impact Assessment (EIA) process for the two concession areas has been carried out simultaneously but separate Environmental Impact Assessment Reports (EIR) have been produced. The Terms of Reference for the EIA is contained in ***Annex A***.

This EIR report has been compiled as the output of the EIA process for SPSL's proposed offshore exploration drilling activities in the Sofala Concession.

The EIR summarises the EIA process, outlines the legislative framework, and provides a description of the project and the biophysical and socioeconomic conditions of the study area. Based on the aforementioned information, impacts of the proposed project activities on the surrounding biophysical and social environment are assessed and evaluated. Recommendations on how negative impacts can be mitigated and positive effects enhanced are provided in the form of an EMP at the end of the report. The report will be used by the Mozambican Ministry for the Coordination of Environmental Affairs (MICOA) as part of the information required for them to make a decision as to whether the proposed drilling may proceed.

Figure 1.1 Regional Locality Map Depicting M-10 and Sofala Concessions



1.2 *PROJECT PROPONENT*

Sasol Petroleum Sengala Limitada, with its offices in Maputo, is a company owned part of Sasol Petroleum International (SPI) Limitada based in Johannesburg, South Africa.

Sasol, as a subsidiary of Sasol Petroleum International (SPI), is a large integrated oil, gas and chemical company with operations on four continents. At Sasol Synfuels in Mpumalanga, the coal mined in South Africa along with Mozambican natural gas, is converted into fuels and chemical feedstock using Fischer-Tropsch technology. Sasol also has chemical manufacturing and marketing operations in Europe, Asia and the Americas. Its larger chemical portfolios include monomers, polymers, solvents, olefins, surfactants, surfactant intermediates, co-monomers, waxes, phenols and nitrogenous products. The company operates through three segments clusters: South African energy cluster (Sasol Mining, Sasol Synfuels, Sasol Oil and Sasol Gas), international energy cluster (Sasol Synfuels International and Sasol Petroleum International) and chemical cluster (Sasol Polymers, Sasol Solvents, Sasol Olefins and Surfactants, Sasol Nitro, Sasol Wax and Infrachem).

In Mozambique, Sasol is currently responsible for onshore gas production in Inhambane Province and is exploring hydrocarbons in the offshore concessions 16 and 19, in Inhambane and Sofala Provinces. Sasol is also extracting and processing crude oil offshore of Gabon in West Africa.

More information about Sasol is available on their website at the following address: http://www.sasol.com.

1.3 *BACKGROUND TO THE STUDY*

Sasol intends to grow their activities in Mozambique by exploring for hydrocarbon prospects in the region. This requires exploratory drilling campaigns.

In accordance with the Government of Mozambique's (GOM) policy to promote international investment in the offshore hydrocarbon industry, SPSL and its partners signed an Exploration and Production Concession Contract (EPCC) with the Government of the Republic of Mozambique for the offshore M-10 and Sofala Concessions *(Figure 1.1),* thereby acquiring an offshore exploration license, effective from 1st February 2010.

The licence for the offshore exploration was issued by the National Petroleum Institute (INP), the Regulatory Authority of the Ministry of Mineral Resources, under the regulations for Petroleum Operations (Decree No. 24/2004 of 20 August 2004).

The Exploration and Production Concession Contract (EPCC) grants exclusive rights to Sasol Petroleum Sengala Limitada (SPSL)(the operating company, with 85%) and ENH (15%), for the exploration and production of commercial quantities of hydrocarbons in the Sofala Concession. Exploration drilling and well-testing activities are planned during the second exploration period and are expected to take place some time during 2011 before the exploration period ends in January 2012 In the event of a discovery of hydrocarbons, SPSL may drill further appraisal wells in order to confirm commercial quantities of recoverable hydrocarbon reserves.

In terms of the EPCC, SPSL is obliged to adhere to all relevant environmental legislation of the Republic of Mozambique, and in pursuance of this obligation, SPSL has committed to undertaking a full EIA. According to the letter (***Annex B***), dated 15/07/2010 from the Ministry for Coordination of Environmental Affairs (MICOA), through the National Directorate of Environmental Impact Assessment, the proposed project was classified as a Category A project, requiring a full EIA, preceded by a Scoping Report. In addition, SPSL is obliged to ensure that its operations comply with international marine legislation and other legislation and conventions to which the GOM is a signatory. SPSL also requires that the EIA adheres to applicable World Bank and International Finance Corporation (IFC) guidelines, and general international best practice.

As part of its commitment to meeting the above requirements, SPSL has appointed Impacto, Projectos e Estudos Ambientais Lda (Impacto) in partnership with Environmental Resources Management Southern Africa (Pty) Ltd (ERM), as independent environmental consultants, to undertake the EIA.

1.4 NEED AND PURPOSE OF THE PROPOSED EXPLORATION ACTIVITIES

The GOM has a policy to promote international investment in the offshore hydrocarbon industry. SPM-10's and SPSL's purpose is thus to explore for reserves of hydrocarbons (gas) in the M-10 and Sofala Concessions, respectively. The proposed activities include exploration drilling and testing of exploration and appraisal wells.

To date, various seismic surveys of the two concessions have been undertaken towards delineating the spatial extent of potential hydrocarbon reserves. The precise and optimal positions for the proposed exploration drilling sites will be confirmed once the results of the seismic surveys are available.

Sasol has been extracting onshore gas resources in Inhambane Province since 2004, and which is processed at the Temane Central Processing Facility (CPF). From the CPF, the gas is fed into a pipeline to supply the local Mozambique market. Natural gas is also fed into a pipeline to the Secunda Plant in South Africa where the gas is processed into various other chemicals and fuel by-products. Offshore gas resources, if viable, will be extracted and linked to the CPF for processing before downstream distribution.

1.5 *ASSUMPTIONS AND LIMITATIONS*

Study assumptions and limitations are listed below:

- Certain details of the project, including the precise location of the two proposed drilling sites, the drill vessel to be used, the exact depth of the wells to be drilled, and the precise composition of the Group III Non-Aqueous Drilling Fluids (NADFs) are not known. The EIA consultants have therefore had to make some assumptions and define the likely operating parameters based on the best available information from SPSL. A worst case scenario has been assumed where the details are not yet known.

- The EIA has evaluated the impacts of drilling the wells to a possible depth of 5,000 metres although it was initially proposed to drill to 2,000 metres. Additional seismic analysis may redefine the required drill depth and thus the impact modelling and prediction assumes the worst case situation eg, maximum quantity of sediment and drilling fluids.

- Although it is undecided the exact type of NADF to be used in the drilling programme, the study has assumed use of a Group III type NADF for the mid and lower sections of the wells in order to overcome expected problems associated with the high clay content on well performance, as was experienced when drilling the Pande and Temane wells in 2007. SPSL would like to retain the option of using NADFs for the proposed drilling campaign in the Sofala Concession.

- The choice of contractor and type of drill vessel to be used in the drilling programme will be finalised by SPSL at a later stage, but is not expected to influence the results of this EIR. The drilling contractor will be expected to comply with the requirements of the EMP and uphold international best practices drilling standards, and meet Sasol's minimum health and safety requirements.

- Should new information become available about the drilling activities, equipment or materials to be used that could influence the outcome or predictions of this EIA then this information will be submitted to MICOA as an addendum to the Environmental Management Plan (EMP). If required, some of the findings and recommendations with respect to mitigation and management actions may need to be reviewed.

- Should additional seismic analysis lead to a shift of the proposed drill site positions within 10 km of the shallow water prawn fishing area or deep water prawn fishing area, then further investigation will be required to clarify the potential impacts on fishing activities. This could include additional cuttings dispersion modelling and discussions with fishery stakeholders and MICOA. An addendum to this EIA would be anticipated that will require approval from MICOA.

- The EIR provides information on the physical, biological and socio-economic aspects of the study area that was sourced from existing and available studies. Most of the information about the broader study area was prepared for a similar study focussing on the Bazaruto Archipelago area, and this has been incorporated where relevant.

- In summary, the EIR covers drilling of a maximum of two wells within the Sofala Concession, located outside of the 10 km buffer zone from the shallow water prawn fishing area, and assumes use of NADFs for the lower well sections. Additional wells will require an addendum to this EIR.

1.6 STRUCTURE OF THIS REPORT

The report comprises six sections and twelve chapters, the structure and contents of which is summarised below:

Table 1.1 Report Structure

Section	Chapter	Description
Section 1	Chapter 1	**Introduction**
	Chapter 2	**EIA Approach & Methodology** Describes the approach to the EIA and the EIA phases.
	Chapter 3	**Legal Framework** Covers the legislative requirements for the EIA and other legal requirements pertinent to oil and gas industry activities, including relevant international conventions.
Section 2	Chapter 4	**Project Description** Provides a description of the proposed exploration well drilling and testing activities.
	Chapter 5	**Project Alternatives** Describes the various technically feasible project alternatives.

Section	Chapter	Description
Section 3	Chapter 6	**Environmental Baseline – Biophysical** Describes the natural attributes of the environment that could be affected by the proposed project.
	Chapter 7	**Environmental Baseline – Socio-Economic** Describes the socio-economic environment that could be affected by the proposed project.
Section 4	Chapter 8	**Impact Description and Assessment:** Describes and assesses the potential impacts of the proposed exploration well drilling and testing activities on the environment, and summarises the mitigation or optimisation requirements for each impact.
	Chapter 9	**Oil Spill Modelling and Impact Assessment** Describes the oil spill modelling study results and assess the potential impacts of a worst case oil spill scenario.
Section 5	Chapter 10	**Environmental Management Plans (EMP)** Provides a framework EMP for minimising the potential negative environmental impacts of well drilling and testing activities and/or to enhancing any positive environmental impacts.
Section 6	Chapter 11	**Overall Conclusion** Summarises the overall findings of the EIA and defines the way forward.
	Chapter 12	**References** Provides a list of the references used in compiling this report.

2 APPROACH AND METHODOLOGY

The approach and methodology that has been followed in conducting the EIA is outlined in this chapter. These comply with applicable Mozambican environmental legal requirements, as described in *Chapter 3*. The EIA consists of three phases (Scoping, Specialist Inputs, and EIA Report and EMP). These phases and the way they relate to one another are illustrated in *Figure* 2.1 and described in *Sections 2.1 - 2.3.*

2.1 PHASE 1: SCOPING STUDY PHASE

The objectives of the Scoping Study Phase were to:

- Present the proposed development to potential Interested and Affected Parties (I&APs);
- Identify issues and concerns about the proposed development;
- Identify potential fatal flaws; and
- Identify and describe those issues which will require detailed investigation under Phase 2 of the EIA process.

The Scoping Phase consisted of a number of activities including:

- Consultation with relevant government departments;
- Distribution of the Background Information Document (BID) to I&APs and invitations to public meetings;
- Advertising of public meetings (through newspaper, radio and website);
- Public meetings;
- Production of the Draft Scoping Report;
- Public review and comment on the Draft Scoping Report; and
- Submission of the Final Scoping Report to the environmental authorities.

The timing of these activities is indicated in *Table 2.1*

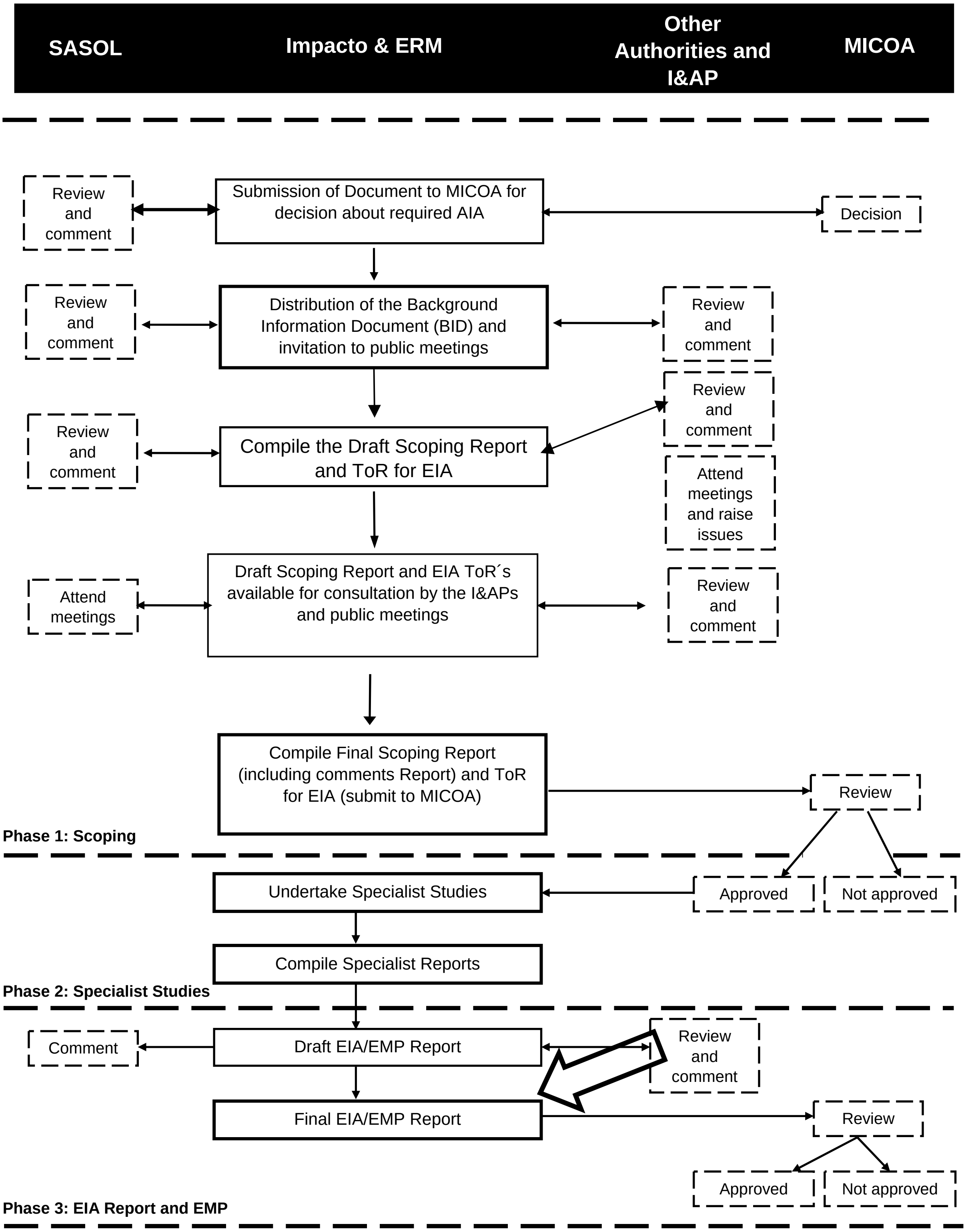
Table 2.1 *Timing of Scoping Activities*

Activity	Place	No. of Participants	Date
Distribution of BID to I&APs	Maputo Beira, Inhambane		5-6 July 2010
Radio and Newspaper Advertisements	Jornal Notícias and Diário de Moçambique and Rádios (Sofala and Save – Nova Mambone)		9 and 20 August 2010
Public meeting	Beira	37	23 August 2010
Public meeting	Maputo	37	24 August 2010
Public meeting	Govuro	46	26 August 2010
Draft scoping report released for public comment			16 Aug – 8 Sept 2010
Final Scoping Report submitted to MICOA for approval	-		17 September 2010
Decision on the Scoping Report			Approved 16 December 2010

The main issues identified by MICOA to be included in the EIA included:

- Ensure list of Abbreviations and Acronyms is comprehensive;
- Include the background of the consultants in the table presenting the Technical Team;
- Include the Investment Value of the exploration phase;
- Take into account the issues raised by Stakeholders in the public meetings;
- Integrate all the affected parties that may require compensation in the Compensation Plan;
- Include mitigation measures for the Sofala Bank fisheryto reduce impacts on this economically important sector for the country;
- Define the periods of communication of the exploratory drilling results to the Interested and Affected Parties;
- Assess impacts on artisanal fisheries and socio-economic impacts which can contribute to the improvement of the livelihood of the local populations, taking into account that these largely benefit from fisheries;
- Assess potential impacts due to overlap of the effects of drilling activities with the Sofala Bank and respective mitigation measures;
- Clarify the potential competition that may arise from the reduction and change of species, which may affect the nutritional quality of the families that depend on fisheries;
- When preparing the Communication Plan, the Proponent together with the Fisheries Sector, shall coordinate the dissemination of the information associated with the wells to the fishing communities; and
- With reference to the EPDA: relating to waste management, include the respective management measures/handling procedures.

Figure 2.1 EIA Process Flow Diagram



2.2 *PHASE 2: SPECIALIST STUDIES PHASE*

The identification of specialist studies required to inform the EIA was based on a combination of issues raised during the scoping phase and the Consultants' (Impacto and ERM) knowledge and previous experience of similar offshore drilling projects. The specialists appointed are listed in *Table 2.2*.

The specialists were required to compile baseline information on their area of expertise as a basis for determination and evaluation of the environmental impacts arising from the proposed drilling activities. The results of the specialist studies have been integrated into the EIR, where relevant, particularly into the baseline description in Chapter 6 and 7, as context for the evaluation of impacts in Chapter 8 and Chapter 9.

Table 2.2 Specialist Studies, and Names and Affiliation of Specialists

Specialist	Affiliation / Organisation	Specialist Study
Almeida Guissamulo (Marine Ecologist)	University of Eduardo-Mondlane, Maputo	Marine Ecology and Mammals
Eugénio Muianga (Maritime Expert)	National Maritime Institute (INAMAR)	Marine Traffic and Navigation Routes
Paula Santos (Socio-economist)	IMPACTO	Socioeconomics
Johan van der Walt (Social and Environmental Consultant)	Independent	Tourism
Atanásio Brito (Fisheries Biologist)	Fisheries Research Institute (IIP)	Fisheries
Lucinda Cruz (Lawyer)	Independent	Legal Framework
Mia Couto/Carlota Quilambo (Ecologists and Public Participation Specialists)	IMPACTO	Public Participation
Eric Comerma (Modelling expert)	Applied Science Associates (ASA)	Drilling Discharge and Oil Spill Modeling

2.3 *PHASE 3: ENVIRONMENTAL IMPACT REPORT (EIR) AND ENVIRONMENTAL MANAGEMENT PLAN (EMP)*

Phase 3 involved the following activities:

- Integration of specialist input and project information into the EIR;
- Assessment of environmental impacts,

- Identification of mitigation measures to manage negative impacts and enhance benefit
- The drafting of a framework EMP.

This document represents the EIR and EMP, compiled in accordance with the requirements of the Regulations on Environmental Impact Assessment, Decree No. 24/2004, and Ministerial Diploma No. 129/2006, which approves the General Directive for Environmental Impact Studies.

As indicated above, the EIR provides recommendations on the mitigation of negative impacts and enhancement of positive effects associated with offshore exploration drilling activities. The mitigation measures have been translated in the EMP into clear and practical measures applicable to the local conditions and based on best oil and gas field practice (eg IFC guidelines and standards where appropriate), and in accordance with requirements of the Petroleum Regulations (Decree No. 24/2004), guidelines of the International Association for Geophysical Contractors (IAGC) and other Mozambican legislation (outlined in Section 3).

Should the environmental licence be issued to permit exploration drilling in the Sofala Concession, the EMP will form part of the service providers' contractual obligations to ensure that the project is conducted and managed in an environmentally acceptable and responsible manner. Subject to approval of the reports and issuance of the environmental license for the exploration project, all associated activities shall be governed by the EMP and in accordance with standard operating procedures of the contracted drilling company.

2.4 *TIMESCALE OF THE EIA ACTIVITIES*

Timing of the key EIA steps is presented in the *Table 2.3* below.

Table 2.3 Timescale of EIA Process

Activity	**Duration**
Scoping Phase	22.06.2010 – 17.09.2010
Specialist Studies	09.07.2010 – 12.08.2010
Compile Draft EIR/EMPs	15.09.2010 – 05.10.2010
Public Review of Draft EIR/EMPs	14.02.2011 – 18.03.2011
Finalise EIR/EMPs	07.03.2011 – 18.03.2011
Submit EIR to MICOA	28.03.2011

2.5 PUBLIC PARTICIPATION AND KEY ISSUES RAISED DURING THE EIA

2.5.1 *Public Participation Process*

The Public Participation Process (PPP) is a stakeholder engagement process that is undertaken throughout the EIA process. The PPP is intended to be transparent and participatory allowing I&APs to fully understand the project activities and the potential implications on the natural and social environment, and to enable them to identify and raise issues of concern that should be considered in the EIA. Stakeholder engagement activities undertaken during the Scoping Study and EIR/EMP phases of this EIA are summarised here. A full description of the PPP and the issues raised are contained in ***Annex E*** of this Report.

The first step of the PPP was the compilation of an initial stakeholders' database as a basis for notifying stakeholders of meetings and distribution of information. This database was updated throughout the process.

PPP events corresponded with the three main stages of the EIA process, namely at the:

- beginning of the scoping phase - to present the proposed EIA process and the project to the public in the form of a Background Information Document as a basis for I&APs to table issues of concern;

- end of the scoping phase – at public meetings to present and discuss the Draft Scoping Report; and

- end of the EIR/EMP phase – at the public meetings to present and discuss the findings of this Draft EIR and to allow additional comments to be incorporated prior to preparing the Final EIR for submission to MICOA.

Throughout these stages, documents were available for public consultation in public access locations and on a website developed for the EIA. These documents are available in Portuguese and English and include, to date, the Background Information Document, the Public Participation Strategy and the Scoping Report. Comment periods were opened for each stage. All the comments received, and their responses, have been incorporated into the Scoping Report.

As with the BID and Scoping Report, the Draft EIR/EMP was made available on the project's website (http://www.erm.com/sasol_sofala_m10) and at strategic locations in the project area (at national, provincial and local level) for I&APs to access and comment on (*Table 2.4*). The Draft EIR was available for two weeks prior to the public meetings to present the findings of the EIA, and for two weeks afterwards to allow submission of additional comments. The Final EIR/EMP to MICOA included all the comments and inputs from I&APs (in Portuguese) and was submitted to MICOA for decision on 28 March 2011 as the basis for their decision on whether to issue an environmental license.

Table 2.4 Locations where the draft EIR/EMPs will be available for public review

Location	Department / Office
National Level: Maputo	MICOA-DNAIA INP IMPACTO SPSL Offices
Provincial Level:	DPCA – MICOA's Provincial Directorate Provincial Directorate of Mineral Resources Provincial Directorate of Fisheries Provincial Directorate of Tourism
Local Level	District Administrations of Dondo, Buzi, Muanza, Machanga and Govuro
Project website	(http://www.erm.com/sasol_sofala_m10)

Three public meetings were held during the Scoping Phase in Beira, Maputo and Govuro in August 2010 (see *Table 2.5*). The second round of public meetings was held at the end of the EIA Phase in the same localities in late February and early March 2011 to present the findings of this report. The meetings were held in Portuguese and the responses in English were translated into Portuguese.

Table 2.5 Summary of Public Meetings

Objective	Location	Date
Present the Draft Scoping Report and EIA's TOR	Beira Maputo Govuro	23 August 2010 24 August 2010 26 August 2010
Present the Draft EIA Report Findings	Beira Maputo Govuro	28 February 2011 1 March 2011 3 March 2011

2.5.2 *Key Stakeholder Issues Raised During Scoping*

The key issues raised by stakeholders during the Scoping Phase are summarised below, separated into different categories of issue.

Fishing:

- Impact of drill cutting disposal and dispersal in the sea on fish distribution and fishing success.

- Impact of drill cutting fluids on the prawn and fishing industry.

- Prohibition or exclusion of fishing activity in certain areas during drilling activities -proposed timing of drilling coincides with main prawn fishing season from April – May.

- The project needs to implement a clearly communicated compensation plan at an early stage prior to drilling and a well-founded communication plan is critical to avoid opportunistic compensation claims). [SPSL is aware of this and has produced such plans that have been applied in previous drilling campaigns].

Biodiversity:

- Potential risk of condensate spill on marine fauna and the Bazaruto Archipelago National Park.

- Need for more research on biodiversity and for Sasol to continue its support for biodiversity protection.

Health and Safety, Maritime Communications and Emergency Procedures:

- Need to consider implications of the project on human health.

- Capacity of Beira institutions to deal with an emergency or pollution event given the lack of oil spill containment measures in Beira.

- Communication methods to notify mariners of drilling rig activities.

Waste

- Disposal of waste drilling fluids/muds given that there is no registered waste management facilities in Mozambique and some private companies do not dispose of them correctly.

Socio-economic Support

- Benefits or contribution of the project to Beira, Sofala and Inhambane Province.

2.5.3 *Key suggestions from stakeholder process influencing the EIA scope and content:*

- Prioritise drilling activities after peak prawn fishing season ie, June onwards.
- Avoid drilling in the semi-industrial fishing area.
- Need for clear communication with the fishermen on compensation and drilling activities to avoid / minimise confusion and potential conflict.
- Undertake communications with fishermen between 18h00 and 19h00 after they return home.
- Use Radio Mozambique for notifications and dissemination of information, and communicate in three languages: Portuguese, Sena and Ndau.
- Distribute EPDA (Scoping reports) via established community structures and forums for ease of access.
- Involve the Fisheries Research Institute, the Small-Scale Fisheries Development, INAQUA and the aquaculture companies in the environmental study, as well as any other institutions identified by MICOA.
- Devise a practical and current emergency and contingency plan to deal with pollution events (including correct contact numbers), and must take into consideration the fact that Beira does not have spill containment measures. Its' preparation and approval should also include involvement of all relevant institutions.
- Implementation of environmental control measures should be checked by an independent commission of technicians to ensure the provisions of the contingency plan are implemented.
- Ensure the compensation and communication plans prepared by the Buzi Hydrocarbon Company for onshore activities, is aligned to the one for Sasol's offshore activities (where they overlap) to minimise risk of conflict.
- Need to include the general principles of a Communication Plan in the EIR/EMPs.

2.6 SUMMARY OF POTENTIAL IMPACTS IDENTIFIED IN THE SCOPING PHASE

The following table of impacts (*Table 2.6*) has been extracted from the Sofala Scoping (EPDA) Report.

Table 2.6 Potential Impacts Identified in the Scoping Phase

Resource / Receptor	Project Aspect / Activity	Impact
Biodiversity		
Marine fauna (including cetaceans, sea turtles and birds)	Support vessel movements. Helicopter operations. Drilling operations. Light from drilling vessel.	Disturbance/damage to fauna due to: • Increased underwater noise • Increased ambient noise • Artificial lighting
Marine ecology	Operational discharges, including cuttings, mud, black water, grey water, drainage water etc.	Changes to water quality including biochemical / toxic effects and increased biological load.
Benthic ecology (benthic habitats and organisms)	Discharge of cuttings and fluids – deposition on seabed.	Smothering and biochemical effects.
	Seabed footprint from infrastructure.	Seabed disturbance and habitat damage.
Socio-economic		
Economy and local businesses	Expenditure.	Stimulation of trade and commerce.
Local communities	Employment and skills development.	Creation of direct and indirect job opportunities and skills training.
Artisanal and commercial fisheries and other users of the sea (eg, shipping and recreation)	Exclusion zone around drilling vessel.	Temporary loss of access to fishing grounds.
	Support vessel movements.	Interference with other users of the sea and potential risk of collisions.
Fish resources and commercial fisheries	Presence of structures and vessels.	Structures and vessels will function as fish attracting devices. Lighting may attract fish resources at night.
Fisheries and other users of the sea	Increased marine vessel traffic Suspended wellheads.	Damage to fishing nets and increased risk of ship collisions.
Tourism	Physical presence and oil exploration activities near tourism areas.	Visual impacts and change in sense of place.
Port facilities	Use of port as a support / logistics base and associated activities.	Increased pressure from water use, noise, light, visual, traffic and waste generation.

Resource / Receptor	Project Aspect / Activity	Impact
Waste Management		
Marine or terrestrial environment and communities	Disposal of waste from drilling and support vessels and disposal of used chemicals.	Contamination of marine (water and fish) and terrestrial environment (groundwater and soil), and secondary health risks to communities.
Atmosphere		
Air quality	Emissions from vessels; Emissions from power generation. Emissions from flaring.	Impacts to air quality and release of greenhouse gasses.
Water		
Surface and groundwater Marine water	Effluents discharges and leaks and spills from onshore base at port. Disposal of drilling fluids and cuttings. Deck drainage and other operational discharges.	Changes to water quality as a result of discharges to the marine environment.
Marine and coastal resources		
Local livelihoods and economy	Accidental releases of condensate or oil/fuel, eg, blowout, loss of containment.	Changes to water quality; Lethal and sub-lethal effects on marine and coastal fauna. Behavioural effects on marine fauna. Contamination of coastal resources. Impacts to livelihoods from decrease in fishing activity due to oil slick and impacts to fishing resource. Impacts to livelihoods from decreased tourism. Impacts on prawn aquaculture farm and on salt pans.

2.7 *INTERNAL PEER REVIEW*

In order to ensure that the EIA meets internationally accepted standards, an internal review of the draft EIA was commissioned and undertaken by the Southern African Institute for Environmental Assessment (SAIEA). The review concluded the EIA was Satisfactory and met acceptable standards for decision-making. Comments and issues raised by SAIEA have been addressed in this report. These mainly concerned the need for more clarity on the type and composition of drilling muds, number and siting of wells, land-based activities and requirements, waste management plans and the other subsidiary plans to be prepared prior to drilling. These plans are in the process of being compiled and will be submitted to MICOA for approval with the final EIA/EMP.

2.8 IMPACT ASSESSMENT METHODOLOGY

2.8.1 Impact Assessment Method

An impact is any change to a resource or receptor brought about by the drilling of a well and associated drilling support activities. Baseline data provides crucial information for the process of evaluating and describing how the project could affect the biophysical and socio-economic environment.

Assessment criteria have been defined to analyse the potential impacts associated with the drilling project. Accordingly, the potential impacts may be categorised in the following types, as summarised in *Table 2.7.*

Table 2.7 Impact Type

Type	Definition
Positive	An impact that is considered to represent an improvement on the existing environmental or socioeconomic aspect or introduces a positive change.
Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (eg between occupation of a site and the pre-existing habitats or between an effluent discharge and receiving water quality).
Indirect	Impacts that result from other activities that are encouraged to happen as a consequence of the project (eg in-migration for employment placing a demand on resources).

The significance of impacts are described as a function of the **magnitude** of the impact and the **likelihood** (or *probability*) of the impact occurring. Impact magnitude (sometimes termed *severity* or *consequence*) is a function of the **extent, duration** and **intensity** of the impact. The criteria used to determine significance varies according to project type and nature of the impacts as well as the context and sensitivity of the receiving environment. For instance, an onshore project has a very different scale of impact than offshore projects. Criteria specified for this offshore project are summarised in *Table 2.8.* Once an assessment is made of the magnitude and likelihood, the impact significance is rated using a matrix as shown in *Table 2.9*. *Table 2.10* outlines the various definitions for significance of an impact.

Significance of an impact is qualified through a statement of the **degree of confidence**. Confidence in the prediction is a function of uncertainties, for example, where information is insufficient to assess the impact. Degree of confidence is expressed as low, medium or high.

In order to ensure impacts are controlled and managed, suitable and practical mitigation measures are identified which are then implemented in terms of the EMP.

The impacts are rated for two situations for each stage of the project: a) for impacts where no additional mitigation measures beyond those that are intrinsic to the project design (and described in the project description) and/or are legislated requirements (here, termed "embedded" mitigation), and b) with additional mitigation measures that are identified during the EIA and which are desirable to further ameliorate the magnitude of an impact. Note that additional mitigation measures do not, however, always change the significance rating of an impact. In this assessment significance ratings are given for the drilling phase and for the post-drilling phase, the latter we refer to as residual impacts.

Table 2.8 Significance Criteria

Magnitude – the degree of change brought about in the environment	
Extent	**On-site** – impacts that are limited to the site area only, ie within 500m of drilling well (exclusion zone). **Local** – impacts that affect an area in a radius of 10 km around the development area, and is largely restricted to within the concession. **Regional** – impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystems, ie extend to areas outside the concession eg coastline of Sofala or Inhambane. **National** – impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences eg Sofala Bank resources. **Transboundary/International** – impacts that affect internationally important resources such as areas protected by international conventions eg Bazaruto National Park.
Duration	**Temporary** – impacts are predicted to be of short duration and intermittent/occasional. **Short-term** – impacts that are predicted to last only for the duration of the drilling and well testing phase, ie 6 months or less. **Medium-term** – impacts that are predicted to extend beyond the drilling phase but not longer than three years. **Long-term** – impacts that will continue beyond three years but within 10 years. **Permanent** – impacts that cause a permanent change in the affected receptor or resource or ecological process, and which endures beyond 10 years.
Intensity (1)	BIOPHYSICAL ENVIRONMENT: *Intensity can be considered in terms of the sensitivity of the biodiversity receptor (ie habitats, species or communities).* **Negligible** – the impact on the environment is not detectable. **Low** – the impact affects the environment in such a way that natural functions and processes are not affected.

(1) The frequency of the activity causing the impact also has a bearing on the intensity of the impact, ie. the more frequent the activity, the higher the intensity.

Magnitude – the degree of change brought about in the environment	
	Medium – where the affected environment is altered but natural functions and processes continue, albeit in a modified way. **High** – where natural functions or processes are altered to the extent that it will temporarily or permanently cease.
	SOCIO-ECONOMIC ENVIRONMENT: *Intensity can be considered in terms of the ability of project affected people/communities to adapt to changes brought about by the project.* **Negligible** – there is no perceptible change to people's way of life. **Low** - People/communities are able to adapt with relative ease and maintain pre-impact livelihoods. **Medium** - Able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support. **High** - Those affected will not be able to adapt to changes and continue to maintain-pre impact livelihoods.
Likelihood - the likelihood that an impact will occur	
Unlikely	The impact is unlikely to occur.
Likely	The impact is likely to occur under most conditions.
Definite	The impact will occur.

Table 2.9 Significance Rating Matrix

SIGNIFICANCE				
		LIKELIHOOD		
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Table 2.10 Significance Definitions

Significance definitions	
Negligible significance	An impact of negligible significance is where a resource or receptor will not be affected in any way by a particular activity, or the predicted effect is deemed to be imperceptible or is indistinguishable from natural background levels.
Minor significance	An impact of minor significance is one where an effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards, and/or the receptor is of low sensitivity/value.
Moderate significance	An impact of moderate significance is one within accepted limits and standards. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that "moderate" impacts have to be reduced to "minor" impacts, but that medium impacts are being managed effectively and efficiently.
Major	An impact of major significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive

significance	resource/receptors. A goal of the EIA process is to get to a position where the project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (ie ALARP has been applied). An example might be the visual impact of a development. It is then the function of regulators and stakeholders to weigh such negative factors against the positive factors, such as employment, in coming to a decision on the project.

3 LEGAL FRAMEWORK

3.1 EXPLORATION AND PRODUCTION CONCESSION CONTRACT (EPCC)

SPSL signed an Exploration and Production Concession Contract (EPCC) with the Government of the Republic of Mozambique for the M-10 and Sofala Concessions. The EPCC was approved by Decree in January 2007. This contract gives SPSL exclusive rights to explore and produce commercial quantities of hydrocarbons in the two concessions. As part of the contract SPSL has committed to drill one well in each concession before the end of the second exploration period at the end of January 2012, and does not envisage it will drill more than two sites per concession within this exploration period. In the event of a hydrocarbon discovery, the concessionaire/operator must declare to the Minister of Mineral Resources whether or not this discovery is 'Potentially Commercial'. Such declaration is usually made based on short-term economic appraisal studies following the discovery.

If SPSL intends to pursue extraction of any commercially viable hydrocarbons found during exploration drilling, a comprehensive Development Plan must be produced that will be submitted to the Council of Ministers for approval before any field development and construction can begin. Such a Development Plan will require the need for a separate EIA focusing on the positive and negative impacts of continuous offshore hydrocarbon production.

The EPCC also establishes and refines the offshore concession's boundaries as illustrated in *Figure 1.1*. The previous concession boundaries extended to the shoreline but SPSL relinquished this portion of the concession ie, 25 percent of the license area, on 1 February 2010 when they entered into the second exploration period(1). *Figure 3.1* shows the area excluded from the concession area. The current concession area within which drilling is proposed is limited to a site within each of the defined M-10 and Sofala Concessions.

In terms of its EPCC with the Government of Mozambique, SPSL is obliged to adhere to the Regulation for Petroleum Operations (Decree No. 24/2004) and all other relevant environmental legislation of the Republic of Mozambique. In pursuance of this obligation, Sasol has committed to undertaking a full EIA.

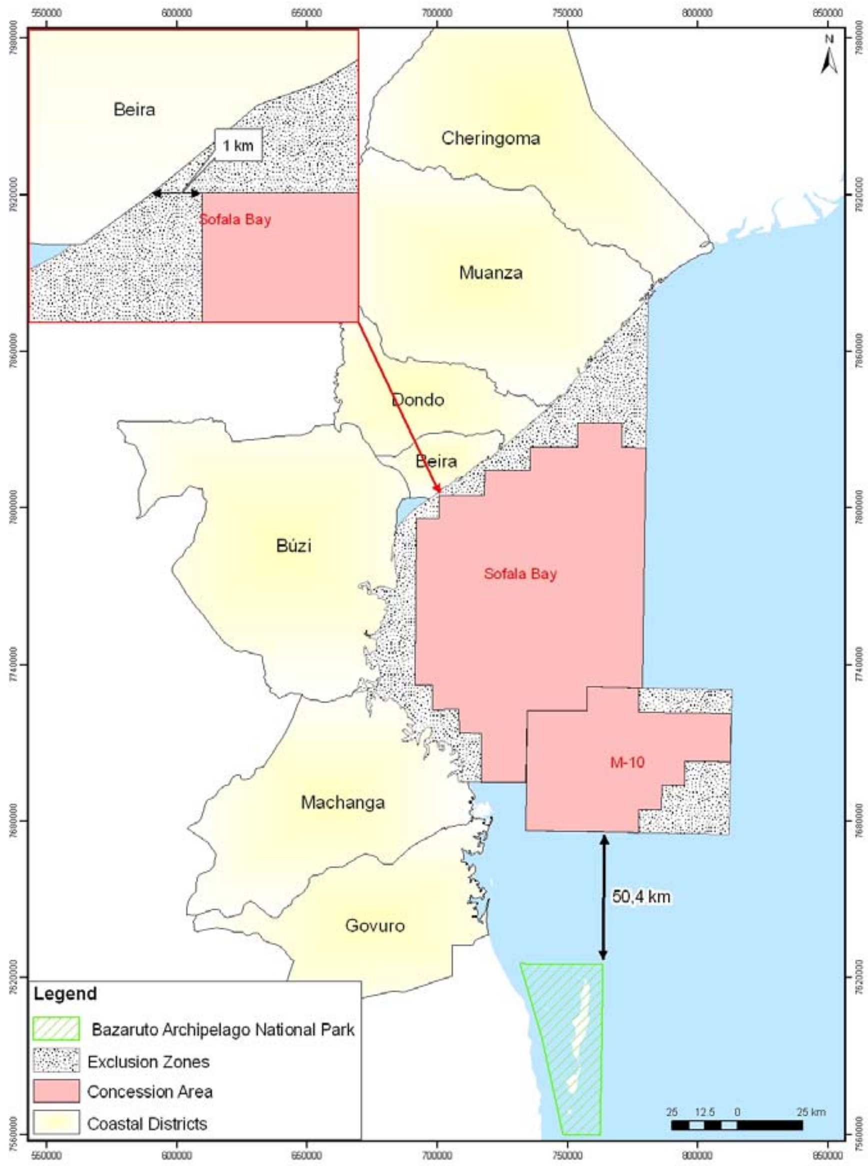
In addition to complying with Mozambican legislation, SPSL is also obliged to ensure that its operations comply with International Conventions to which the Republic of Mozambique is a signatory. Several conventions and agreements

(1) At the end of each exploration period the concessionaires have to relinquish part of the license.

have been identified which relate to marine and coastal environments, and hazardous substances. Relevant international conventions and national legislation for the proposed Offshore Exploration Drilling Operations are presented below in *Sections 3.2* and *3.3.*

In addition, Sasol's Safety, Health and Environmental Policy will also guide management approaches throughout the proposed exploration activities as well as international guidelines for the Petroleum Industry Sector (see *Section 3.5*).

Figure 3.1 Regional Base Map depicting the M-10 and Sofala Concessions including Areas excluded from Concession Areas



3.2 INTERNATIONAL CONVENTIONS

Table 3.1 International Conventions Relevant to the Oil and Gas Industry to which Mozambique is a Signatory

International Convention	Key Issue	Relevant Provisions
Pollution and Safety at Sea		
International Convention for the Prevention of Pollution from Ships (*MARPOL* 73/78)	Pollution at Sea by Ships	MARPOL provides regulations covering the various sources of ship-generated pollution, including regulations for the prevention of pollution by oil, sewage, garbage (galley waste and solid waste) and atmospheric emissions. (Mozambique has signed but not ratified the Prevention of Air Pollution from Ships). MARPOL specifies the following standards applicable to SPSL's Offshore Drilling activities: *Drainage and ballast water*: release of oily water within 12 nautical miles of land or in a special area is prohibited. Beyond 12 nautical miles, the oil content of effluent must be less than 100 parts per million. Vessels are required to have onboard oil discharge monitoring and control system, and oil/water separation equipment. *Noxious substances*: Specifies the discharge criteria and control measures of noxious substances. No discharge allowed within 12 nautical miles. *Sewage*: specifies maceration of residues (e.g. galley and sewage waste) to <25 mm, and allows discharge of disinfected waste more than 3 nautical miles and non-disinfected waste more than 12 nautical miles from the nearest coast. *Solid waste/ garbage*: prohibits discharge to sea of all plastic, as well as tins, glass, packaging etc. *Exhausts/Gases*: Sets limits on sulphur content of heavy oils to 4.5%m/m[1] globally or SOx emissions to a maximum of 6g/kWh measured as SO_2. NOx emissions are set between 9.8 to 17 g/kWh depending on the engine's maximum operating speed. Use of halons and chlorofluorcarbons (CFCs) are forbidden in new ships and beyond 1 January 2020 in existing facilities.

(1) [1] 4.5%m/m means that the mass of the substances is 4.5% of the total mass of the solution or mix

International Convention	Key Issue	Relevant Provisions
UN Law of the Sea Convention, 1982 (*UNCLOS*)	Pollution at Sea and Compensation for Damage	UNCLOS deals with prevention of marine pollution and the compensation for damage caused by such pollution. It contains provision relating to the prescription and enforcement of pollution standards and contingency plans to prevent and handle pollution. Signatories are required to adopt legislation to reduce marine pollution from seabed activities in the EEZ and on the continental shelf.
International Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, 1972 (*London Convention*)	Dumping at Sea	The London Convention (in force since 1975) was one of the first to protect the marine environment from detrimental effects arising from human activities. Its objective is to promote the effective control of all sources of marine pollutions and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter. The "London Protocol" of 1996, upgrades the 1975 London Convention, and prohibits dumping of waste at sea, except for possibly acceptable wastes on the so-called "reverse list". The Protocol came into force on 24 March 2006 and there are currently 37 Parties to the Protocol.
Oil Spills & Compensation		
Oil Pollution Preparedness, Response and Co-operation Convention (OPRC), 1995	Oil Pollution from Offshore Units	OPRC requires the establishment of national programs for responding to oil pollution incidents, and operators of offshore units are required to have oil pollution emergency plans that are coordinated with the national oil response program and approved in accordance with procedures established by the competent national authority. It specifies provisions relating to oil pollution combating equipment, reporting, training, salvage and international cooperation on oil pollution and prevention.
International Oil Pollution Compensation Fund (IOPC), 1992	Payment of Compensation for Oil Spill Damage	IOPC provides an international regime of liability and compensation for oil pollution damage caused by oil spills from tankers, making the owner of a tanker liable to pay compensation up to a certain limit for oil pollution damage following escape of persistent oil from his ship. If the provision is insufficient to cover all admissible claims, further compensation is available from the 1992 IOPC Fund if the damage occurs in a State which is a member of that Fund.
International Convention on Civil Liability for Oil Pollution Damage, 1992 (*CLC Protocol*)	Liability for Oil Spill Clean-up	The CLC Protocol provides for a compensation fund for clean up costs and environmental damage subject to certain conditions and limits.
Convention for the Prevention of Marine Pollution from Land-based Sources (*Paris Convention*), 1974	Pollution of the Sea from Land Sources	The Paris Convention provides for the control of pollution of coastal waters from land-based sources.

International Convention	Key Issue	Relevant Provisions
Convention on the International Regulations for Preventing Collisions at Sea (COLREGS), 1972	Vessel Safety / Collisions at Sea	COLREGS provides guidance to determining safe speed, reducing risk of collision, and the conduct of vessels operating in or near traffic separation schemes.
International Convention for the Safety of Life at Sea (SOLAS), 1974	Safety of Life at Sea	SOLA provides guidance for the safety of merchant ships, including prescribing the number of lifeboats, and other emergency equipment and safety procedures for merchant ships. It also provides a framework for evaluating security risks through the implementation of an International Ship and Port Facility Security Code.
Convention on the International Maritime Satellite Organisation (INMARSAT), 1989	Maritime Communications	INMARSAT provides guidance on improving maritime communications to assist in the event of distress or incidents concerning safety of life at sea, the efficiency and management of ships, maritime public correspondence services, and radio determination capacities.
Regional Cooperation and Coordination of Maritime Search and Rescue & Global Maritime Distress and Safety System (GMDSS)	Coordination of Maritime Disasters	GMDSS establishes Sub-Regional Search and Rescue Centres for Coastal African Countries and an international telecommunications system using terrestrial and satellite technology to assist with maritime disasters. This is co-ordinated by the International Maritime Organisation (IMO).
Environmental Protection		
African Convention on the Conservation of Nature and Natural Resources, 1968	Protection of soil, water, flora and fauna	This Convention provides for the adoption of measures to ensure conservation, utilisation and development of soil, water, flora and faunal resources in accordance with scientific principles and with due regard to the best interests of the people.
Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region, 1985, and the Protocol for Protected Areas, Wildlife and Vegetation; and Protocol for the Cooperation in the Combat of Pollution in Emergency Situations	Marine and Coastal Protection, Marine Pollution, and Protection of Protected Areas, and Threatened Flora and Fauna in the East Africa Region	This Convention provides for the implementation of appropriate measures to maintain essential ecological processes and life support systems, to preserve genetic diversity, and to ensure the sustainable utilisation of harvested natural resources, and to prevent, reduce and combat pollution arising from vessel discharge, deposition of waste and other material in the sea, coastal settlements, rivers and estuaries, sea floor and sub-soil exploitation and atmospheric discharges. Obliges signatories to pay special attention to areas with rare or fragile ecosystems, and rare, threatened or endangered vegetation, animals and their habitats. It also provides for cooperation in combating pollution in emergency situations in the East African Region, and the reporting of marine pollution incidents.
Convention on the Conservation of the Migratory Species of Wild Animals, 1979, and amendments	Conservation of Migratory Species	This Convention guides the conservation of wildlife, particularly animals that migrate across or outside national jurisdictional boundaries. (This includes turtles, whales, pelagic sea birds etc).

International Convention	Key Issue	Relevant Provisions
Protocol for the Fisheries of the SADC, 2001	Protection and Use of Fisheries	This Protocol provides for the conservation of aquatic ecosystems, including their biodiversity and unique habitats which contribute to the livelihood and aesthetic values of the people and the Region. Commits signatories to apply the precautionary principle to ensure that activities do not cause excessive transboundary adverse impacts, and to take concerted actions to protect endangered living aquatic species and their habitats.
Convention on Wetlands of International Importance especially as Waterfowl Habitat (*Ramsar Convention*)	Wetland Protection	Ramsar obliges signatories to conserve and protect wetlands (and therefore to protect such systems from pollution and degradation).
Convention on Biological Diversity (CBD), 1992	Biodiversity Protection	CBD obliges signatories to protect biodiversity and, in particular, to adopt measures for recovery and rehabilitation of threatened species. It indirectly promotes environmentally sound integrated pollution and waste management practices.
Climate Change		
Vienna Convention for the Protection of the Ozone Layer, 1985, and various protocols and amendments	Protection of the Ozone Layer	The Vienna Convention provides for signatories to take appropriate measures to protect human health and the environment against adverse effects resulting from human activities that may modify the ozone layer, and to regulate use of substances that destroy the ozone layer.
United Nations Framework Convention on Climate Change (UNFCCC), 1992	Reduction of Greenhouse Gases	UNFCCC aims to stabilise greenhouse gas concentrations in the atmosphere. Most parties to the Kyoto Protocol (1997) under this convention agree to legally binding reductions in greenhouse gas emissions of an average of 6-8% below 1990 levels between 2008 and 2012.
Hazardous Waste		
Convention on the Ban of the Import into Africa and the Control of Trans-boundary Movements and Management of Hazardous Wastes within Africa (BAMAKO Convention), 1991	Transboundary Movement and Importation of Hazardous Waste	BAMAKO prohibits the import of hazardous waste into Africa and controls the transboundary movement of hazardous waste.
Cultural Heritage		
Convention Concerning the Protection of the World Cultural and Natural Heritage (*World Heritage Convention*), 1972	Cultural Heritage Protection	The World Heritage Convention promotes cooperation among nations to protect heritage from around the world that is of outstanding universal value that its conservation is important for current and future generations.

3.3 NATIONAL LEGAL FRAMEWORK

3.3.1 *Summary of National Legislation and Regulations*

A number of laws and decrees governing environmental protection of natural resources that are linked directly or indirectly to the petroleum industry are listed in *Table 3.2*. Legislation that is relevant to petroleum drilling activities are examined more closely in *Section 3.3.2*.

Table 3.2 List of Key Environmental Laws and Decrees related to Petroleum Industry Activities

Legal Instrument	**Number / Reference**
Constitution of the Republic of Mozambique, 2004	
Approval of the National Environmental Policy	Resolution 5/95 of 3 March 1995
The Environmental Law No.20 of 1997	Law No.20 of 1997 (1 October 1997)
EIA Regulations: Regulations on EIA Process	Decree 45/2004, 29 September 2004, altered by Decree 42/2008, 4 November, and by Dispatch of 5 March of 2008
General Directives for EIA	Ministerial Diploma No.129 of 2006 (19 July 2006)
General Directives for Public Participation Process in EIA	Ministerial Diploma No.130 of 2006 (19 July 2006)
Regulations on Environmental Quality and Effluent Emissions Standards	Decree No.18 of 2004 (2 July 2004)
Regulations for the Environmental Audit Process	Decree No.32 of 2003 (12 August 2003)
Regulations for the Environmental Inspection	Decree No.11 of 2006 (15 June 2006)
Petroleum Law No.3 of 2001	No.3 of 2001
Regulation on Petroleum Operations	Decree No.24 of 2004 (20 August 2004)
Regulations for the Prevention and Protection of the Marine and Coastal Environment	Decree No. 45 of 2006 (30 November 2006)
Law of the Sea No.4 of 1996	Law No.4 of 1996 (4 January 1996)
Forestry and Wildlife Law No.10 of 1999	Law No.10 of 1999 (7 July 1999)
Regulations on Recreational and Sport Fishery	Decree No.51 of 1999 (31 August 1999)

3.3.2 *Legislation Relevant to Petroleum Activities and the Environment*

This section summarises the provisions of Mozambique's national legislation that is relevant to the petroleum industry and potential impacts on the environment. The full legal report is contained in ***Annex C***.

Table 3.3 Key Provisions of National Legislation Relevant to Petroleum Industry Activities and the Environment

Legal Instrument	Key Provisions
Legal Framework of the Petroleum Industry	
Constitution of the Republic of Mozambique, 2004	• Article 98.1 indicates that the natural resources within the territory of Mozambique are exclusively owned by the Republic. Article 102 entitles the State to promote the evaluation of its natural resources and determines their use and conditions of exploitation in compliance with the country's interests.
Petroleum Law No. 3 of 2001	• The preamble indicates that petroleum resources are regarded as assets that, when properly exploited, can contribute to national development. • Requires licence holders to ensure avoidance of ecological damage caused by petroleum operations, and to observe internationally accepted norms. • Specifies the requirement for an EIA where an activity may cause environmental damage, including mitigation measures. • Requires cleanup of sites following operations and to implement rehabilitation. • A management plan is required for the control of waste products and for pollution prevention. • Requires submission of a Survey Plan (including EIA) to the National Petroleum Institute within five weeks of starting activities.
Regulations on Petroleum Operations (Decree 24/2004) under Petroleum Law)	• Defines the types of petroleum operations; terms and conditions of contracts; practices, including the management of resources, safety, health and environmental protection, as well as the submittal of plans, reports, data, samples and other information by the holders of rights to conduct petroleum operations. • Petroleum Operations are governed by a Concession Contract issued for Survey; Exploration and Production, and Construction and Operation. • The Operator of such activity is required to report any discovery to the National Petroleum Institute within 24 hours, and to the NPI informed of the test results and the evaluation of the discovery (including drilling activities) • The Operator is required to undertake the technical and commercial evaluation to conclude whether a discovery may be commercially developed, and within one year must submit an appraisal report to the Minister with authority over the petroleum industry. This shall include a declaration of commerciality with a complete description of the relevant data, surveys and evaluations that led to the conclusions. • Based on the Declaration of Commerciality submitted by the Operation, the Government will decide whether it will exercise its right to participate in the development and production of the deposits. • If the deposits are found to be commercially viable, the Operator is required to prepare a Development Plan, programming the Development and Production of the corresponding deposits for a period of two years from the Declaration of Commerciality. This Plan must include the EIR. • If the deposits are unsuitable for practical commercial

Legal Instrument	Key Provisions

	development, the Operator is required to provide information on additional measures to render the development commercially practical or propose additional tasks to evaluate the commerciality.
	• Article 75 specifies the general requirements for drilling and other well operations, in order to ensure activities are conducted in a safe manner with all due safety precautions to protect health, safety and the environment. This includes the need for an Emergency Plan in the event of a blow-out of a well, and which identifies suitable locations for drilling of a relief well and includes a plan for mobilisation of personnel, equipment and services.
	• Article 77 specifies operational requirements, and provides for the use of oil based and synthetic oil based drilling fluids only when required. It also specifies the requirement for verifying fluid volumes in the well, formation testing, testing of well control equipment, and location of zones with flow potential to prevent eruption of hydrocarbons.
	• Article 82 regulates management of hazardous material, specifying the need for safe storage, handling, labelling and use of hazardous material and chemicals.
	• Article 86 provides general Emergency and Contingency Requirements.
	• Article 87 requires the Operation to submit to the NPI a Contingency Plan for handling accidents and hazardous situations, and specifies the content of such plan. It also requires the NPI to be notified prior to carrying out emergency exercises and to receive a report on such exercises.
	• Article 88 indicates that the NPI may require installation of certain emergency equipment at facilities, while Article 89 deals with issues of Health, Work Environment and Safety and the requirements of the Operator in this regard.
	• Article 90 cover *Environmental Protection* and requires operators to:
	  • Undertake an EIA, including mitigation measures
	  • Prevent damage to personnel, third parties and animal, vegetation, marine life and monuments
	  • Prevent marine pollution and air pollution
	  • Monitor and reduce the effect of all operational and accidental discharges, and to keep operational discharges to the limits defined by the environmental regulatory authorities, and to keep the NPI informed of pollution events
	  • Take remedial measures and repair damage when activities endanger human safety or health or the environment
	  • Give preference to using materials and chemicals least dangerous to health and of greater safety to minimise the risk to persons, environment and facilities, and to recycling.
	  • Take due consideration of all health related aspects including provision and qualifications of medical staff and health services, hygiene, potable water etc.
	
	New regulations on the Environmental Impact of Petroleum Operations have been drafted but have not yet been enacted through publication in the Boletim da Republica (Government Bulletin).

Legal Instrument	Key Provisions
Legal Framework for Environment	
Constitution of the Republic of Mozambique, 2004	Defines the rights of all citizens to live in a balanced natural environment and their obligation to protect it, as well as the State's obligation to promote initiatives and implement policies to prevent and control pollution and to integrate environmental objectives in all public sector policies to achieve this goal.
National Environmental Policy (Resolution 5/95)	Lays the foundation for all ancillary environmental legislation in order to achieve sustainable development by balancing socio-economic development needs with environmental protection. It aims to ensure the management of the country's natural resources to preserve their functional and productive capacities for present and future generations.

The Environment Law (Law No.20 of 1997)	• Defines the legal basis for the sound use and management of the environment to safeguard sustainable development in the country, and is applicable to all activities in the public or private sector affecting the environment
	• Core principles of the policy and law include:
	  • Environmental management to improve quality of life and protect biodiversity and ecosystems
	  • Recognition and value of traditions and knowledge of local communities
	  • Prioritisation of systems that prevent degradation
	  • Holistic and integrated perspective of the environment
	  • Importance of public participation
	  • Principle of Polluter Pays
	  • Importance of international cooperation in appropriate environmental management.
	• Under Article 8, GOM is required to create adequate mechanisms for public participation in environmental management from the drafting of policies and legislation to their implementation
	• Article 9 proscribes the production and deposit of any toxic and polluting substances in the nation's soils, sub-soils, water or atmosphere

EIA Regulations (Decree 45/2004)	*Environmental Impact Assessment* • EIA is an instrument designed to assist GOM in making decisions regarding issuing of environmental licenses for development projects. The issuing of an *Environmental License* shall precede any other required legal licenses. • *Screening and Project Classification:* The first stage of an EIA is environmental screening which defines the extent and type of EIA required for a given project (as per the World Bank EA Guidelines). A Category A project is one that could have significant impacts due to the nature of the project and sensitivity of the area, and requires a full EIA with EMP. Category B relates to projects that could have negative impacts but of lower significance and require a Simplified EA, while Category C projects do not require an EA. • *Criteria for Classification as Category A*: Exploration well drilling and well testing in M-10 and Sofala Concessions is classified as Category A, and are subject to a full EIA. Relevant criteria under Decree 45/2004 for this drilling project include: • Project is located near mangrove areas (at the mouths of the Pungue, Buzi, Save and several other rivers),

Legal Instrument	Key Provisions
	- Project is located in and close to an important fishing ground – the Sofala Bank – regarded as one of the most important fishing ground in Mozambique for artisanal and industrial fishermen; - The activity will take place close to a prawn aquaculture project; - There will be a potential impact on livelihoods of local communities, and - The activities involve exploration for hydrocarbon derivatives. • *Steps of a Full EIA*: The Regulations describe the steps involved with undertaking a Category A project. These are: a) Registering the project with MICOA; b) Preparation of an Environmental Pre-feasibility and Scoping Study (EPDA), with Terms of Reference for the EIS, and c) the EIS study (including impact assessment and public consultation). See legal ***Annex C*** for more detail on these steps and the reporting requirements. MICOA is required to approve the EPDA prior to proceeding with the EIS. • *Content of a Full EIS*: The EIS is required to contain the following: - Non-technical summary of the main issues, conclusions and proposals - Legal framework governing the activity and its integration in the existing local development plans in the zone of influence of the project - Description of project activities and different actions foreseen - General description of the environment - A description and comparison of alternatives, and prediction of the future environmental situation with and without the project - Identification and assessment of impacts and mitigation measures - Environmental Management Plan, including monitoring of impacts, environmental education program and contingency plans in case of accidents - Identification of the multidisciplinary team that undertook the EIA - A Public Participation Report • *Public Participation Process* is a compulsory activity for Category A projects. It implies delivery of information to all directly and indirectly affected and interested parties, responses to public requests for explanation and formulation of suggestions. • *Time frames for authority decisions*: The environmental assessment authority, MICOA, is required to comply with the following deadlines: - Pre-assessment: 5 working days - EPDA and TOR – 30 working days - EIS – 45 working days

Legal Instrument	Key Provisions
Regulations on Environmental Inspection (Decree 11 of 2006)	Provides for Ordinary and Extraordinary Inspections by MICOA of development activities that may cause negative environmental impacts to verify if recommendations or mitigation measures in EIAs have been applied and, if not, the current state of the environment.
Other Environmental Laws	
The Sea	
Law of the Sea No. 4 of 1996	• Defines the limits of the Mozambique territorial sea and its Exclusive Economic Zone (EEZ) as 200 miles from the territorial sea, which in turn is defined as 12 miles from the coastline. Within the EEZ the GOM has sovereign rights to exploration, conservation and management of resources as well as other economic activities.
Regulations for the Prevention of Pollution and Protection of the Marine and Coastal Environment (Decree 45 of 2006)	• Forbids the disposal of any substance that may pollute the water and beaches, including pollution by hydrocarbon products. • Requires the determination of appropriate measures to prevent and limit pollution resulting from illegal discharges from ships, platforms and land-based sources. • Requires establishment of a legal basis for the protection and conservation of the maritime, lacustrine and fluvial public domain areas of beaches and fragile ecosystems. • Applies to all national or foreign natural or legal persons performing activities that may cause negative impacts on the coastal and marine environment. • Applies to discharge of harmful or dangerous substances by ships, in ports, harbour facilities, coastal emissions, platforms or other land-based sources, including inland waterways; territorial waters of Mozambique; the Mozambique Channel; the EEZ and in international waters. It applies to all domestic and foreign ships navigating jurisdictional waters of Mozambique and facilities off the Mozambique coast. • *Waste:* Requires all ports, port facilities, platforms and emission facilities along the coast to have adequate waste collection and treatment facilities for various types of waste. Owners of such facilities are required to have waste management procedures approved by the regulatory authority; as contingency plans for oil pollution or other dangerous substances, and to keep a waste record book. • *Transport of hydrocarbons or other dangerous substances:* covers issues related to this aspect and requires obligatory Record Books, notification of their onboard location, and covers packing and labelling. • *Hydrocarbon discharge*: covers all aspects related to oil and harmful discharges, prohibiting discharge in waters of national jurisdiction; defines exceptions, and obligations with respect to communication of incidents. Regulation refers to MARPOL standards with respect to oil and harmful liquids. • *Discharges of waste from drilling*: makes provision for preparation of regulations relating to this issue but these have not been prepared by MICOA. • *Pollution events:* defines the role and options of the maritime authority to avoid pollution and covers incidents and compensation issues.

Legal Instrument	Key Provisions
Regulations on Environmental Quality and Effluent Emissions Standards (Decree 18 of 2004)	• Regulates the disposal of industrial liquid effluent. Requires the point of discharge to be determined during the environmental licensing process and to meet discharge standards. • Discharge of pollutants that can potentially affect bathing areas must be controlled through monitoring, and defines the water quality parameters for recreational purposes.
Water Resources	
National Water Policy (Resolution No.46 of 2007) and Water Law No. 16 of 1991.	• Defines the basis for water resources management based on principles of "user pays" and "polluter pays" • The zone of influence of the drilling project lies within the jurisdiction of ARA-SUL, the regional water administration body.
Regulations on effluent quality standards (Decree 18 of 2004)	• Defines effluent quality standards for receiving water bodies, treatment technologies, systems and methods.
Regulations on Water Quality for Human Consumption (Ministerial Diploma No. 180/2004)	• Apply to potable water supply systems for human consumption, including surface and groundwater for direct consumption. • Ministry of Health is responsible for water quality control for human consumption.
Atmospheric Emissions & Air Quality	
The Environment Law No.20 of 1997 and Emissions Standards Regulations (Decree 18 of 2004)	• Prohibits the release of any polluting and toxic substances to the atmosphere beyond the legally established limits. • The Regulations defines maximum emissions for the different categories of vehicles but do not define emission limits for Lead although most vehicles still use leaded petrol. Emissions for ships and maritime vessels are not defined. • Requires noise emission standards to be approved by MICOA but these have not been published.
Solid Waste Management	
The Environment Law No.20 of 1997	• Prohibits the disposal of pollutants in soils or release of pollutants to the atmosphere or water bodies beyond legally established limits. • Prohibits the importation of hazardous waste into Mozambique
Water Law No. 16 of 1991	• Prohibits the accumulation of waste that can contaminate water resources.

Legal Instrument	Key Provisions
Waste Management Regulations (Decree 13 of 2006)	• Provides guidance on disposal of waste and practice of polluting activities that could pollute or impair the environment. • Describes the responsibilities of MICOA for implementation of these regulations. • Waste generators are required to submit for approval a Waste Management Plan before any activities commences. On approval, MICOA issues a waste management licence for the activity, valid for 5 years. Application for renewal must be submitted 180 days before the expiry of the licence. • *General Waste:* Waste producers are required to minimise waste; separate different waste categories; treat waste before disposal; train and protect workers handling waste; minimise contamination risks during transport; guarantee waste elimination will not negatively impact the environment or public health and safety; and annually register origin and amount of waste handled, transported, treated, recycled, or eliminated. Records must be retained for five years after registration. • *Hazardous Waste*: must be segregated according to stipulated waste classes. Covers collection, storage, packaging, transport, treatment, disposal and reporting of hazardous waste. A manifest in quadruplicate must be completed of quantities, quality and destination of collected waste with the last copy sent to MICOA. Transportation of waste by road must comply with the Road Transport Code and using hauliers certified for this purpose by MICOA.
Regulations for the Management of Ozone Depleting Substances (Resolution No. 78 of 2009)	Bans the import, export, production, commercialisation and transit of ozone depleting substances and equipment containing such substances. The following are banned: Chlorofluorocarbons, Halogens, Carbon Tetrachloride, and other substances defined by the Montreal Protocol.
Protection of Biodiversity and Conservation Areas	
Land Law No 19 of 1997 and Land Law Regulations (Decree No. 66 of 1998)	• Classifies land as partial or total protection zones. The latter refer to areas designated for nature conservation, defence and national security and which shall be defined in separate regulations. Partial protection zones include territorial seas, the EEZ, continental platform and coastline, islands, bays and estuaries up to 100m inland of the maximum high tide mark. • Use of land in both total and partial protection zones requires issuance of a specific licence for the required purpose. Approval of petroleum and gas infrastructure requires the automatic creation of a partial protection zone 50m beyond the area.
Forestry and Wildlife Law, No 10 of 1999; Forestry and Wildlife Regulations (Decree No.12 of 2002)	• Defines protection zones as being areas within the national boundaries and representative of national natural heritage, designated for biodiversity conservation. • National Parks comprise total protection areas for natural ecosystem preservation as well as for scientific, cultural or aesthetic value. Surveying or prospecting for minerals and drilling or other activities likely to alter the aspect or habitat or causing water pollution, are prohibited within the boundaries of a National Park. • The Regulations list protected fauna species that are illegal to hunt (eg dugongs, turtles, flamingos, seagulls, pelicans, herons).

Legal Instrument	Key Provisions
Recreational and Sport Fishing Regulations (Decree No.51 of 1999)	Lists protected marine species, including dugongs, whales and dolphins, turtles and some species of fish and shark, bivalves (giant and scaled clam) and gastropods (horned helmet and trumpet triton).
Cultural Heritage	
Cultural Heritage Protection Law No. 10 of 1988 and Regulations for the Protection of the Archaeological Heritage	• Protects monuments, buildings with historical importance, artistic and scientific places, and natural elements of particular scientific and aesthetic interest (eg Bazaruto Archipelago) • Any discovery of a site, object or document likely to be classified as cultural heritage, requires notification of the administrative authorities within 48 hours.
Forestry and Wildlife Law, No. 10 of 1999	Defines areas of historic-cultural use and value as protected areas.

3.4 *INSTITUTIONAL RESPONSIBILITIES*

The key institutions and their main roles and responsibilities in relation to environmental protection and the petroleum industry are summarised in *Table 3.4.*

Table 3.4 Summary of Institutional Responsibilities

Institution	Roles and Responsibilties

Ministry for the Coordination of Environmental Affairs (MICOA)	• MICOA is responsible for coordinating all environmental activities at a national level in order to promote the management, preservation and rational use of the country's natural recourses as well as to propose environmental policies and strategies for integration in sector development plans. The Ministry promotes the sustainable development of the country through the steering implementation of the country's environmental policy.
	• The relevant directorates for Environmental Impact Assessment studies are:
	  • National Directorate for Environmental Management with responsibilities for policy making; setting standards; defining sustainable development indicators and promoting environmental conservation actions.
	  • National Directorate for Environmental Impact Assessment with responsibilities for legislation proposals, licensing of activities, coordinating the EIA process and preparing guidelines; monitoring environmental impacts, and auditing.

Institution	Roles and Responsibilties
National Petroleum Institute (INP)	• INP is the regulatory body for hydrocarbon research, production and transportation activities. • It is a legal entity governed by the public law, based in Maputo but with delegations in the provinces. • It's scope includes the evaluation and maintaining the knowledge base of petroleum resources in Mozambique, promotion of investment in petroleum surveys and participates in defining the contract and work obligations of contract and concession holders. • INP must inspect the locations, buildings and facilities where petroleum operations are conducted and observe the execution of petroleum activities, including inspecting all assets, registry and data in the possession of the operator. • INP is responsible for supervision and monitoring of all aspects of seismic and drilling exploration and must ensure that the proponent complies with the EMP and other operating conditions.
National Maritime Institute (INAMAR)	• INAMAR is a legally constituted public institution with administrative and financial autonomy created by the government of the Republic of Mozambique through relevant administration. Its roles are prescribed under Decree 32 of 2004: Regulatory Maritime Authority. • INAMARS's aim is to act in the fields of maritime safety, protection of ships and port facilities, maritime transportation, agency and stowing, maritime personnel, preservation of marine environment and maritime administration. • It is involved with the licensing of maritime equipment and material; promoting actions to prevent and fight maritime pollution; coordination with other authorities in search and rescue activities; ensuring communication between vessels and coastal stations; control handling and transport of dangerous goods, and investigate incidents and maritime offences. INAMAR is also responsible for licensing and supervising diving activities and towing and maritime rescue. • It's responsibilities towards protection of the marine environment include proposing legislation and regulations to combat pollution by vessels, coordinating actions to fight marine pollution, and participating in forums to establish rules and standards in this regard.
National Hydrography and Navigational Institute (INAHINA)	• INAHINA are responsible for safety of maritime navigation, in the form of "Notice to Mariners" for maritime navigation in Mozambique's waters. • It is responsible for preparation and sale of nautical publications such as charts, navigation routes, list of lighthouses, tide tables etc. and is also responsible for the operation and maintenance of navigation aids.
National Aviation Institute (IACM)	Administers helicopter use and issues permits. An operator must obtain a permit from IACM to bring or operate a helicopter in Mozambique.

3.5 SASOL'S SAFETY, HEALTH AND ENVIRONMENTAL POLICY

Sasol's Safety, Health and Environmental (SHE) Policy establishes the framework for the management of the organization's activities, including the exploration activities envisaged in the Sofala concession. This policy is provided below:

Safety, Health and Environmental Policy

We, the people of Sasol, striving for excellence in all we do, recognize the impact that our activities can have on people and the environment. Safety, health and protection of the environment will form an integral part of our planning and decision-making. We will manage our company, wherever we do business, in an ethical way that strikes an appropriate and well-reasoned balance between economic, social and environment needs.

We are committed to:

- Conducting our business with respect and care for people and environment
- Responsible utilization of natural resources
- Implementing responsible care for all Sasol's chemical and associated businesses. Non-chemical businesses will implement appropriate, recognized codes of practice
- Continually improving our safety, health and environment performance
- Complying, as minimum, with all applicable legal and other agreed requirements
- Promoting dialogue with stakeholders about safety, health and environmental performance

We will achieve these by:

- Implementing internationally recognized safety, health, environmental and quality management systems
- Developing and implementing inherently safer and cleaner technologies
- A "cradle to grave" approach to the products we develop, manufacture, use, distribute and sell
- Informing and appropriately training all employees and contractors on safety, health and environmental matters
- Responding effectively to safety, health and environmental emergencies involving our operations and products
- Engaging with relevant authorities and institutions on the formulation of legislation, standards and the implementation thereof
- Benchmarking internationally on best safety, health and environmental practices
- Sharing safety, health and environmental risk reduction best practices throughout Sasol
- Providing appropriate resources required to implement the above

Pat Davies
Chief Executive

3.6 INTERNATIONAL GUIDELINES

3.6.1 *International Association of Drilling Contractors*

The International Association of Drilling Contractors (IADC) Guide is designed to supplement company Health, Safety and Environmental programs and operating procedures. It is based on experience and careful study over many years. Practicability has been substantiated by the adoption of the safe operating procedures by many drilling contractors and government regulatory bodies. It provides a basis for the drilling contractor to develop a Health, Safety and Environmental programme.

Of particular interest for the present project is Chapter 12 of the IADC guide, related to Offshore Safety, covering aspects such as medical evacuation and rough weather procedures; and Chapter 14, related to the Protection of the Environment covering air emissions, waste management, spill prevention and control amongst others.

The Guide also covers aspects related to Fire Prevention and Control, Personal Protective Equipment and Emergency Action Plan(s). These are also addressed in the Mozambican Regulations for Petroleum Operations, as described in *Table 3.3* above.

3.6.2 *International Association for Oil and Gas Producers (OGP)*

The International Association for Oil and Gas Producers (OGP) has been producing documents and guidelines over the past few years to assist its members to develop best practices in Health, Safety and Environment. Of special importance for the project are:

- Environmental aspects of the use and disposal of non-aqueous drilling fluids associated with offshore oil and gas operations – it provides a comprehensive synopsis of what is known around the world about the environmental impacts of this discharge;

- Environmental management in oil and gas exploration and production – it provides an overview of the environmental issues and the technical and management approaches to achieving high environmental performance in the activities necessary for oil and gas exploration and production around the world;

- Guidelines for the development and application of Health, Safety and Environmental Management Systems – it describes the main elements necessary to develop, implement and maintain a Health, Safety and Environmental Management System by the operators;

- Exploration and Production (E&P) Waste Management Guidelines – it provides a general description of waste management principles; identifies and provides an overview of E&P activities and associated wastes; and recommended options of waste reduction, recycling, treatment and responsible disposal; and

- Key questions in managing social issues in Oil and Gas Projects – it provides a tool to help with social planning issues and is targeted at: project management, by helping to identify questions that may be important in their leadership role; and business and project teams, by helping in the identification of questions that may be important in project development and management.

Section 2

Project Description and Alternatives

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4 PROJECT DESCRIPTION

4.1 PROJECT OVERVIEW

4.1.1 Motivation

Sasol Petroleum Sengala Limitada (Exploration Production Concession Contract Sofala) and Sasol Petroleum M-10 Limitada (Exploration Production Concession Contract M-10) (hereafter referred to as SPSL and SPM-10, respectively) are planning to conduct offshore exploration drilling activities in the Sofala and M-10 Concessions off the coastline of Sofala Province, Mozambique.

Exploration drilling and well testing operations are undertaken to determine whether sub-surface geological structures, referred to as 'prospects', contain hydrocarbons in potentially commercial quantities. Drilling operations generally take place after a seismic survey has been completed or when old seismic data is available, allowing a well to be accurately located over a prospect.

A number of offshore seismic acquisition programmes have been conducted in the area, such as ARCO's seismic survey in 1998 and the BANG survey in 2008, as well as exploratory drilling in the Sofala Concession by ARCO in 2000. Based on seismic survey analysis, the objective of SPSL's exploration well-drilling activities in the M-10 and Sofala Concessions is to confirm the presence of economically viable reserves of hydrocarbons in the form of gas deposits. If such gas reserves are found, SPSL intends to develop these to expand existing markets and to develop new markets in the region.

In the event that a commercially viable discovery is made, SPSL will be required to submit an Appraisal Programme to the GOM. The purpose of an appraisal programme is to delineate the reservoir to which the discovery relates in terms of thickness and its lateral extent as well as to estimate the quantity of recoverable hydrocarbons therein. Typically, such an appraisal programme involves additional seismic surveys and drilling of wells around the discovery but this will be subject to a separate EIA and licensing process.

In terms of the EPCC, SPSL has committed to drill one well site before the end of the second exploration period by 31 January 2012, and does not envisage it will drill more than two sites per concession within this exploration period. Any additional wells would require an addendum to this EIR.

4.1.2 *Project Location*

The Sofala Concession is situated offshore of the coastline of Sofala Province (*Figure 4.1*) near Sofala's capital of Beira. The two drilling sites Delta and Charlie are located 23 km and 73 km from shore, respectively. The closest southern boundary of the concession is located approximately 60km from Bazaruto Archipelago National Park (BANP) to the south.

4.1.3 *Prospects and Well Locations*

Based on the interpretation of previous seismic data, and for the purpose of modelling dispersion of drill cuttings, two separate locations with different exploration drill depth objectives that may contain hydrocarbons have been identified. Initial analysis of seismic results indicated the need to drill to a shallow objective (2,000 m) and a deep objective (3,000 m), but further investigation and analysis suggests drilling may be required to be undertaken to 5,000 m depth to reach viable gas deposits. As a result of this current uncertainty, sediment deposition modelling and environmental impact assessment has been based on a 5,000m drill depth, and has therefore considered the worst case scenario.

Two provisional exploration well site positions have been identified based on results of previous seismic campaigns, one in the deep objective and one in the shallow objective of the Sofala Concession. These approximate positions have formed the basis for modelling of drill cutting dispersion in order to predict the potential impacts on the marine environment. The nominal locations of these wells are shown in *Figure 4.1* and coordinates are provided in *Table 4.1* below.

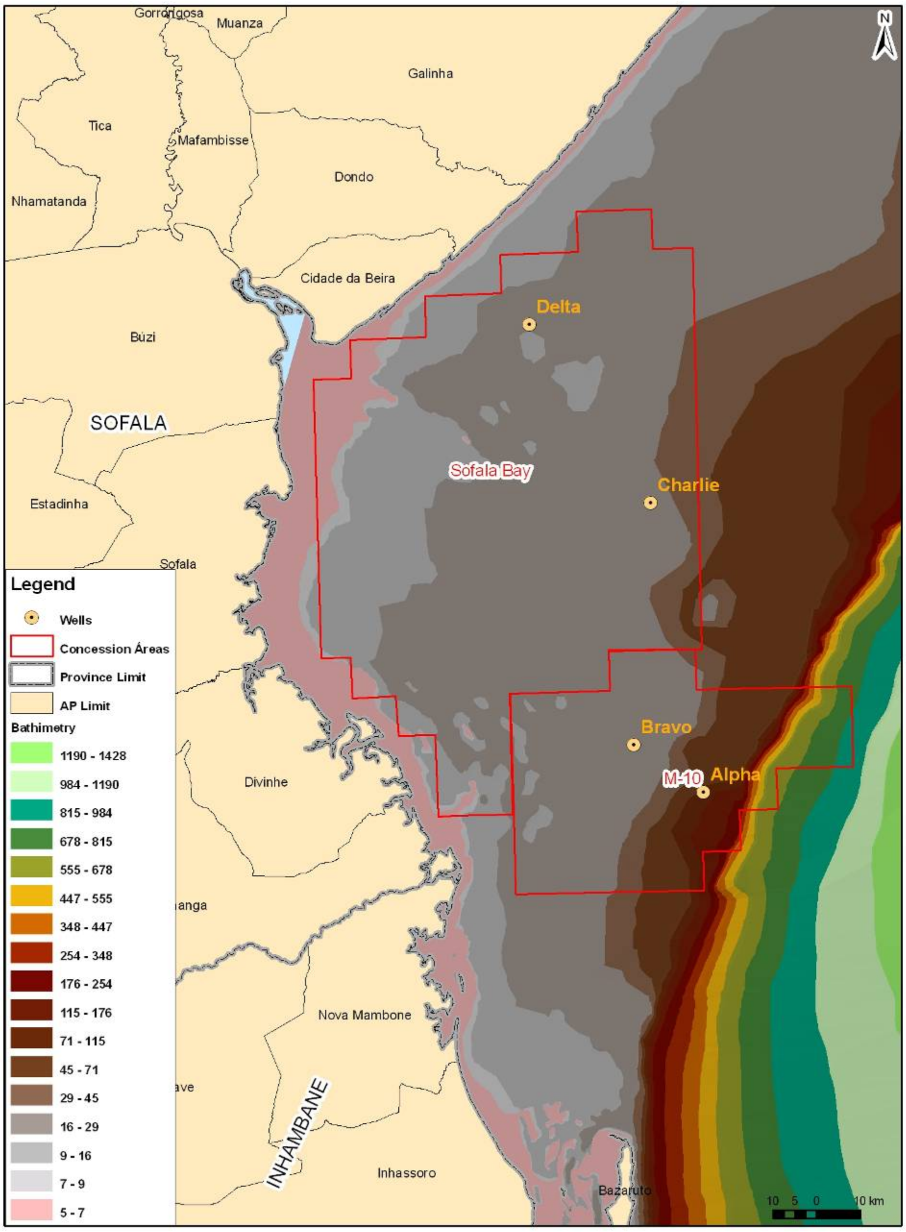
Additional detailed analysis of seismic results is required to confirm the exact locations of these two wells, which could lead to a shift in the order of a few kilometres in any direction. Provided that the final well positions are not shifted closer than approximately 10 km from the shallow water prawn fishing area or the deeper water prawn fishing area (see *Figure 7.4*) the findings of this environmental assessment as presented in this report are unlikely to change. Should further seismic analysis reveal a preferred drill location closer to the fishing areas, then further investigation will be required to clarify the potential impacts on fishing. This could include additional cuttings dispersion modelling and discussions with fishery stakeholders and MICOA. An addendum to this EIA would be anticipated that will require approval from MICOA.

Table 4.1 Approximate Sofala Well Locations and Anticipated Drill and Water Depths

Well Name	Prospect	Approximate Water Depth	X-coordinate (WGS84)	Y-coordinate (WGS84)
Charlie	Deep (5,000 m)	30 m	20° 11' 37.57" S	35° 34' 02.56" E
Delta	Shallow (2,000 m)	20 m	19° 49' 08.22" S	35° 18' 33.80" E

It is expected that SPSL may drill up to two wells within the Concession, of which one may be drilled to 5,000m.

Figure 4.1 Concession Area Showing Approximate Well Locations (Charlie and Delta) for Sofala



4.1.4 *Project Timing*

The EPCC *minimum* work commitments require SPSL to drill one exploration well before 31 January 2012, when the second exploration period expires. In the event of a discovery of hydrocarbons, further appraisal wells may be drilled in order to confirm commercial quantities of recoverable hydrocarbon resources, but this would be subject to approval on an addendum to this EIR. Each exploration well drilling operation is expected to last between 40 and 45 days, followed by well testing which will be conducted over a period of approximately 10 to 15 days in total.

Given the nature of the offshore exploration activities, well drilling must be conducted during the dry winter months where there is limited probability of the occurrence of tropical cyclones. In Mozambique, this optimal weather window falls between March and November. Exploration drilling and well-testing activities are currently scheduled for the period between March and November 2011. However, as offshore drilling rigs are currently in short supply due to the high demand, the availability of a drilling vessel may determine this schedule.

4.2 *EXPLORATION WELL DRILLING AND TESTING*

4.2.1 *Drilling Vessel*

Various types of drilling vessels are used worldwide in off-shore drilling operations. Alternative drilling vessels types are illustrated in *Figure 4.2,* and discussed further in *Section 5.3.4*. It is expected that exploratory drilling in the Sofala Concession will be conducted using a jack-up rig.

A jack-up rig is a mobile, self-elevating drilling platform with legs that can be lowered to the sea bed (see *Figure 4.3*). When the legs are secured on the seabed, the drilling vessel provides a secure platform for drilling operations to proceed. The rig provides onboard accommodation for all operational personnel requirements. A full survey of seabed conditions beneath the feet of a jack up rig will be required to ensure the rig is securely established.

The wellhead arrangement for a jack-up drilling vessel will be on the surface of the seabed, similar to a land-based drilling operation. In the case of a Jack Up Rig, the Blow Out Preventer (BOP) is typically located on the rig and connected to the well by means of a casing string. In the absence of deploying well control equipment on the seabed, operations are much simpler than for floating drilling vessels.

A jack-up rig is normally cheaper to operate than a floating vessel. However, the transport of a jack-up rig involves the use of a specialised transport vessel which is in global short supply.

Figure 4.2 Drilling Vessel Types According to Water Depths

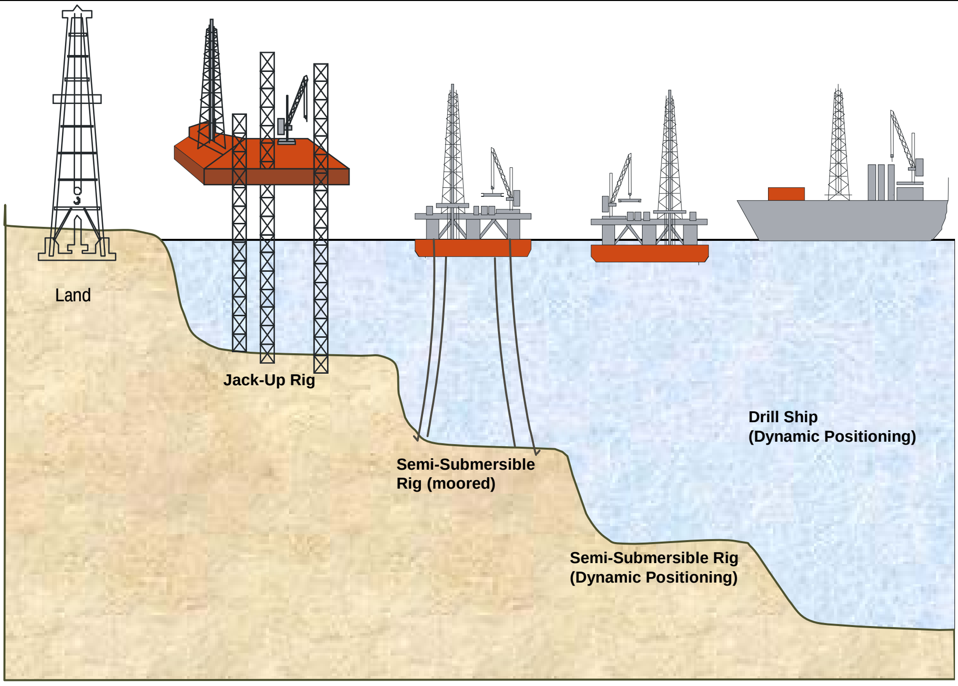


Figure 4.3 Jack-up Rig

The drilling vessel will be towed to site using two tug vessels. It is not anticipated that the drilling vessel will enter any of the ports in Mozambique. Should the drilling vessel need to clear customs it will do so at Beira Port.

4.2.2 *Pre-Drilling Survey*

A geotechnical site survey of new drilling areas and locations will be undertaken. The purpose of these surveys is to assess the following:

- the possibility of intercepting shallow gas;
- the possible occurrence of shallow faults;
- potential instability of the seafloor at the selected drill site;
- that the selected drill site is suitable for the placing of the wellhead equipment (eg that the seafloor is smooth and no rocky formations or debris is present which could prevent the effective placing of the drilling guide bases; and
- to assess possible problems with anchoring.

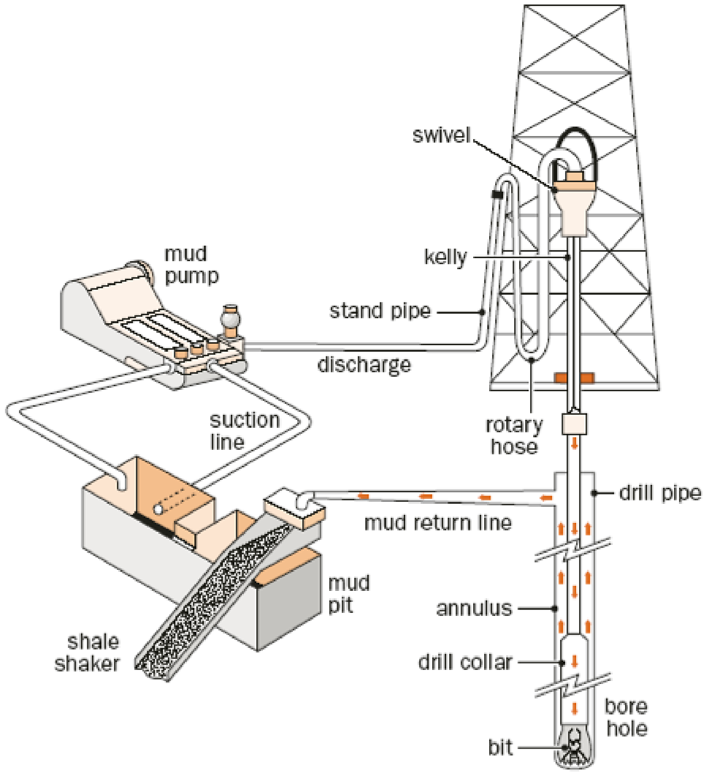
Pre-drilling site surveys may involve shallow penetration seismics, side-scan surveys, bathymetry and possibly current measurements, and soil boring to check founding conditions for the drill rig.

4.2.3 *Drilling Equipment and Method*

The drilling vessel will drill the wells using equipment, such as a derrick, draw works, drilling fluid handling equipment, power generators, cementing and testing equipment, a Blow Out Prevention (BOP) unit and tanks for fuel and water. *Figure 4.4* is a schematic showing the equipment and process of well drilling. The derrick supports equipment to raise, lower and rotate the drill string.

A section of casing called a conductor will connect the well from the sea floor to the drilling vessel and the BOPs. Drilling will be undertaken by lowering the drill string through the riser to the seafloor and rotating the drill string, causing the drill bit to crush the rock into small rock fragments. The fragments of rock dislodged by the bit are called 'cuttings'. As additional drill pipe is added to the drill 'string', the well depth increases.

Figure 4.4 *Drilling Equipment*



Drilling of the first (upper) section of the well with water based fluids may not be drilled using a conductor and cuttings would be discharged directly to the sea floor. Once drilling of the mid and upper sections commences, non-aqueous drilling fluid (also referred to as mud) is continuously circulated down the drill string and back to the surface equipment. The cuttings would be removed from the bottom of the hole in a drilling fluid (*Figure 4.4* and *Figure 4.5*). The use of specifically designed drilling fluid has crucial functions in the drilling process, such as suspension of cuttings, pressure control, stabilisation of the borehole walls, lubrication and cooling of the drill bit, among others. Drilling fluids are discussed further in *Section 4.3*.

Drilling is periodically stopped to allow new sections of pipe to be added to the drill string or to replace the drill bit. Casing will be run and cemented into the previously drilled hole sections to protect fresh water aquifers, isolate subsurface formations, and to provide structural support to the borehole. The casing is designed to ensure the safe and efficient drilling of the well. Drilling will take place in subsequently smaller size holes until the total depth of the well is reached. A typical casing diagram is provided in *Figure 4.6*.

Figure 4.5 Circulation of Fluids in the Drill Bit

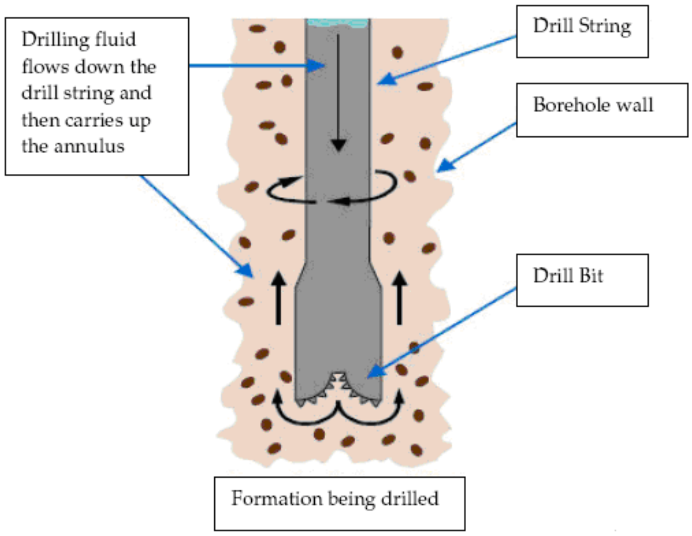
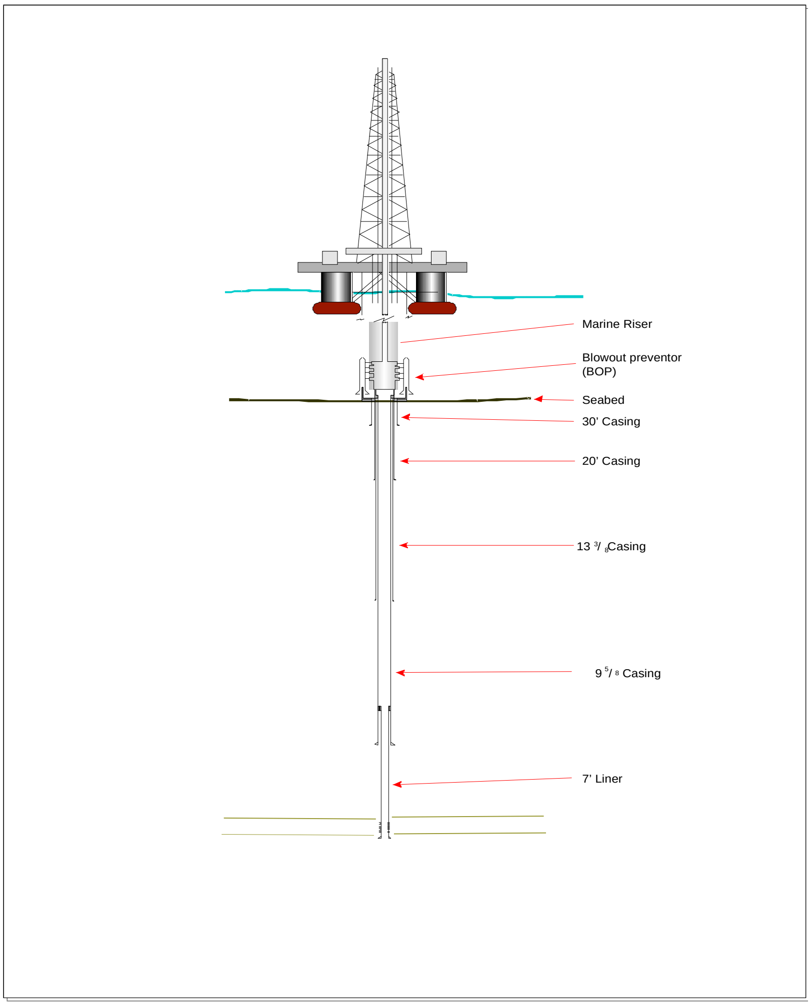


Figure 4.6 Typical Casing Diagram



Note: diagram shows situation with BOP on sea floor not on drilling vessel as in the case of a jack up rig.

4.2.4 *Drilling Fluid Circulating System and Solids Control Equipment*

While drilling of the mid and lower sections of the well is in progress, drilling fluid is continuously pumped down the inside of the hollow drill string. The fluid emerges through holes in the drill bit and then rises (carrying the cuttings with it) up the annular space between the sides of the hole (the casing and marine riser) and the drill string, to the rig drill floor. Cuttings are separated from the non-aqueous drilling fluid (NADF) by solids control equipment before the fluid is re-circulated.

The solids control system sequentially applies different technologies to remove formation solids from the drilling fluid and to recover most of the NADF associated with the cuttings so that it can be reused. A typical solids control system consists of the following main components:

A diagram of an advanced drilling fluid circulating system on a drilling rig is shown in *Figure 4.7*. The components of the solids control system will depend upon the type of drilling fluid used, the formations being drilled, the available equipment on the rig, and the specific requirements of the disposal option. Solids control may involve both primary and secondary treatment steps.

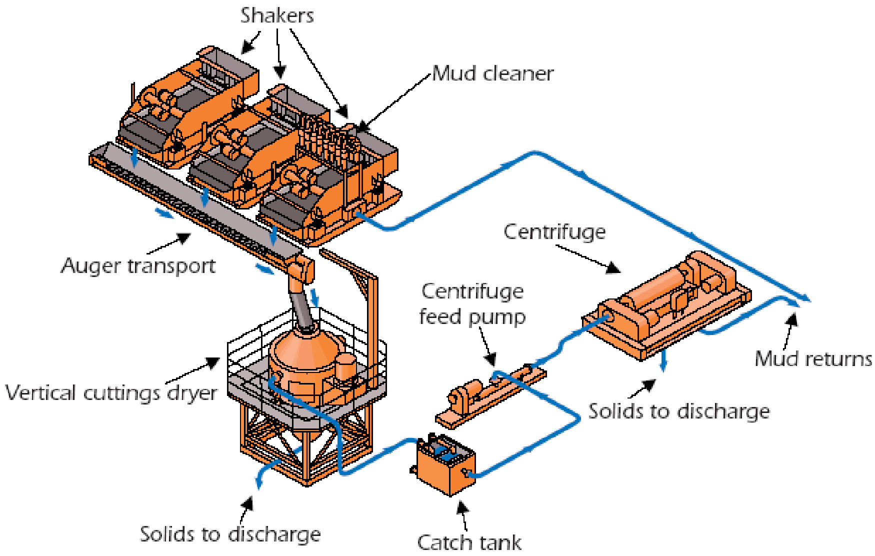
Traditional solid control equipment involves shale shakers (vibratory screens) to recover and reuse 85-90% of the drilling fluid associated with the cuttings. Secondary equipment is used to recover more of the recover drilling fluids normally lost overboard when cuttings are discharged. The systems include the following.

- *Drying shaker system:* comprising an extended deck shaker with high gravity vibrators with a centrifuge to remove fines. This type of system achieves a waste reduction to less than 10% by weight oil on cuttings.

- *Cuttings dryer system*: waste would be reduced to 6 to 8% by weight oil on cuttings using a combination of cuttings dryer and centrifuge recovery system.

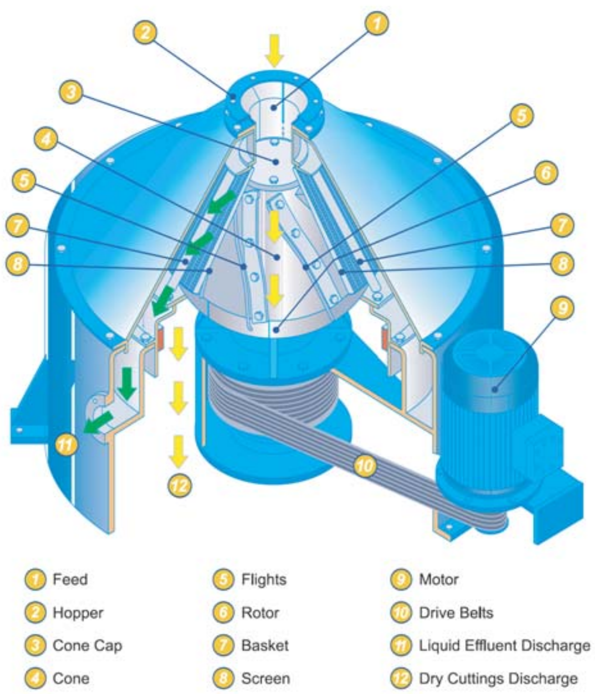
- *Cuttings dryer and solids control system*: this is made up of cuttings dryer (*Figure 4.8*) and high speed decanting centrifuge and a high performance decanting centrifuge system operating on the active drilling fluid system to remove ultra fine cuttings from the drilling fluid which reduces oil on cuttings to 5% by weight. Generally dryers comprise a screen rotated at high speed to produce damp to dry cuttings.

Figure 4.7 Advanced Solid Control System Including a Secondary Treatment System



(Source: OGP, 2003)

Figure 4.8 Vertical Cuttings Dryer



Source: TWMA, 2010

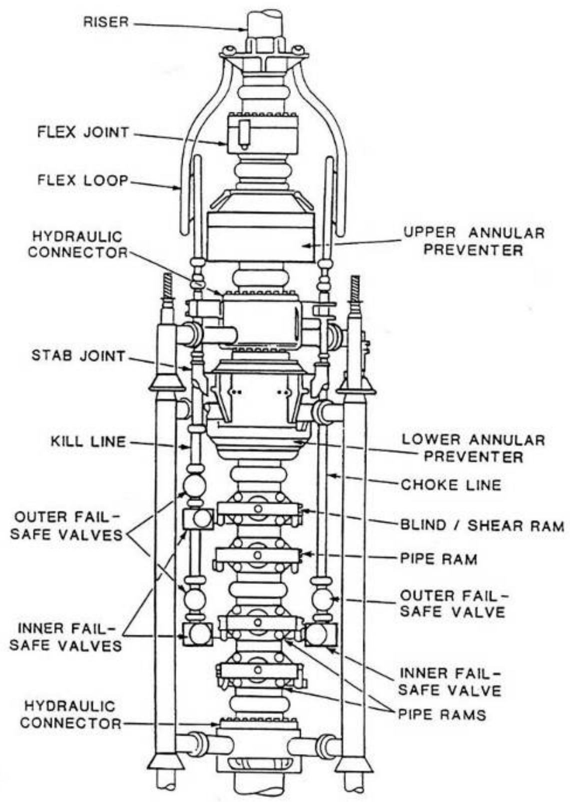
Options for the disposal of cuttings and fluids were investigated. It was recommended to use standard solids control systems as well as dryers to minimise the quantity of residue oil on cuttings as far as is achievable with current technology. SPSL has committed to continuous improvement by enhancing cuttings treatment to reduce oil on cuttings to less than five percent as a weighted average. Given that anaerobic conditions slow down the rate of biodegradation and result in increased toxicity of the sediments, it is desirable to disperse cuttings over a wider area to aid biodegradation. This would minimise the risk of a build up of drill cutting with associated potentially anaerobic conditions and higher toxicity. NADF cuttings with oil content reduced to 5% and dried, will, when flushed with seawater hydrate quickly and disperse like water-based cuttings thus reducing the formation of cutting piles and organic enrichment (OGP 2003).

4.2.5 Well Control (Blow-Out Prevention)

The uncontrolled release of hydrocarbon (gas or condensate) is probably the greatest potential environmental concern during exploratory well drilling. Clearly, it is also the greatest safety concern and consequently, well control is fundamental to this drilling process. Normally, the weight of the drilling fluid in the well bore is designed to counteract the natural well pressure. If the natural formation pressure is higher than forecasted in the well design, formation fluids may be released into the wellbore in an uncontrolled fashion; a situation referred to as a 'kick'.

BOPs are designed to shut in a well in such an event, by means of rams and annular preventers that physically close off the well aperture. All drilling vessels will be equipped with a BOP (see *Figure 4.9* and *Figure 4.10*) and all equipment is thoroughly inspected prior to installation and subsequently pressure-tested on a routine basis.

Figure 4.9 Diagram of a Typical Subsea BOP Stack



(Source: CCA & CMS, 2001)
Note: This BOP shows riser attached to the top of BOP which is not applicable to BOP on Jack Up Rig

Figure 4.10 Photograph of BOP on Jack Up Rig

4.2.6 *Well Design*

No detailed well engineering design has been undertaken yet but will be conducted to best international safety and engineering standards and practise. Well design will depend upon factors such as planned depth, expected pore pressure and anticipated hydrocarbon-bearing formations. Characteristics of a typical deep well are shown in *Table 4.2*. The data and information from previously drilled wells in the region will be reviewed and incorporated into the design.

Table 4.2 *Typical Well Design*

Casing Size (in)	Hole Diameter (in)	Depth (m)	Interval
30	36	100	100
20	26	300	200
13.375	17.5	1000	700
9.625	12.25	3500	2500
7	8.5	5000	1500

4.3 *DRILLING FLUID (MUDS)*

4.3.1 *Overview*

Drilling fluid (or drilling mud) is formulated according to the well design and expected geological conditions. It comprises a base fluid, weighting agents and chemicals that are used to give the drilling fluid the exact properties it needs to make it as easy and as safe as possible to drill the hole. If the drill bit penetrates a formation containing oil, gas or water under pressure these formation fluids are prevented from flowing into the borehole by ensuring that the drilling fluid is of sufficient density to counteract the natural formation pressures.

Drilling fluid also serves the following functions:

- The removal of cuttings from the bottom of the hole and their transport to the surface and separation from the fluid;
- Deposition of an impermeable cake on the wellbore wall to seal the formations being drilled, preventing contaminants entering the fluid and/or the fluid entering the formation;
- Suspension of cuttings in the fluid during interruption of drilling;
- Maintaining structural stability of the wellbore;
- Cooling of the drill bit; and
- Lubrication of the drill string.

There are two broad categories of drilling fluid; Water Based Drilling Fluids (WBDFs) and Non-Aqueous Drilling Fluids (NADFs). These different categories of drilling fluids are used for different types of wells and often for different sections of wells, and there are a wide range of types of each drilling fluid used by the oil and gas industry around the world. For both types of drilling fluid a variety of chemicals are added to the water or non-aqueous continuous liquid phase to modify the properties of the fluids. NADFs are divided into three groups, according to the level of aromatic content.

Group III fluids, which have low to negligible aromatic content, were developed more recently mainly to address environmental issues related to overboard discharge (being more readily biodegradable and less toxic than other NADFs), and to reduce occupational hygiene issues for drill crews. Group III fluids include enhanced mineral oil-based fluids derived from highly processed petroleum-based oils using special refining and/or separation processes and synthetic-based fluids which include olefins, paraffins, and esters.

Poly-aromatic hydrocarbons (PAHs) are toxic pollutants and the concentration in drilling fluid has been reduced from the Group I fluids (where diesel typically had 5-10% PAH). Group II fluids were developed to reduce this concentration to around 0.35% and Group III fluids have PAH concentrations less than 0.001%.

4.3.2 *Proposed Drilling Fluid Composition*

The drilling program includes the use of both WBDF and NADF. NADFs are required for the proposed project as the reservoir sands deposited in the Cretaceous Grudja Formations contain relatively high percentages of clay minerals, which absorb and swell in contact with water of a different salinity, and which causes reduced well performance. This situation was experienced when drilling in Pande and Temane in 2007.

The specific NADF that would be used has not been confirmed, but SPSL has confirmed that it would be a Group III NADF. WBDF would be used for drilling the upper sections (36", 26"), thereafter adding a potassium chloride (KCL)/Polymer to drill the 17.5"section at approximately 1,000 m below the seabed. NADF would be used to drill the lower sections of each well (12.25" and 8.5" at a depth below approximately 3,500m. Drilling discharges are discussed in *Section 4.11.3*. The final choice of NADF will be based on technical performance characteristics, environmental criteria and regional availability

Water Based Drilling Fluids

Different drilling fluid properties and composition are achieved by adding chemicals to water. The main constituents of WBDF are sea water mixed with bentonite clay and barium sulphate (see *Figure 4.11*).

Table 4.3 gives an overview of the main components of the WBDF that is expected to be used.

Figure 4.11 Water Based Drilling Fluid Composition

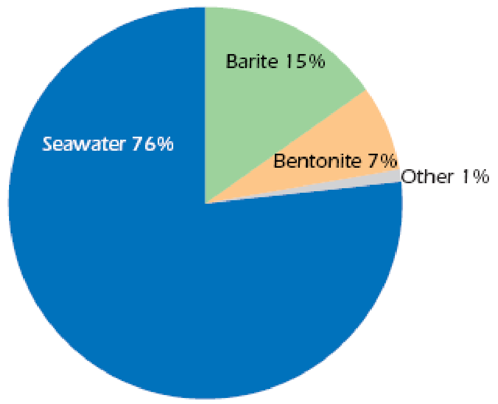


Table 4.3 Main Components of Water Based Drilling Fluid

#	Component	Main Function
1	Sea water	Mixed with the dry components to form the discontinuous or liquid phase of the drilling fluids.
2	Bentonite	Type of clay mineral that swells when mixed with fresh water. It is added to increase viscosity and gel strength.
3	Barite	Used as a weighting agent to increase the density of drilling fluids.
4	Polymer	Organic substances used to reduce fluid loss and to thicken drilling fluids e.g. starch, xanthan gum or guar gum.
5	Potassium chloride, Gypsum, Lime	Used to control ionic balance to stabilize clays and shales.
6	Various other chemicals (see *Table 4.4*)	Used to control pH, inhibit corrosion, and prevent growth of bacteria or fungi in the fluid.

Natural clay (bentonite) and high viscosity polymers are used as viscosifiers. Barium sulphate (as barite, a naturally occurring heavy mineral) is used as weight material to control subsurface pressures. The solubility product of barite is very low at 1×10^{-10}. Sea water contains 2.7 grams sulphate per litre and barite is therefore practically inert in the marine environment.

Various other additives such as thinners, filtration control agents, lubrication agents and numerous other compounds for specific functions forms part of the drilling fluid (see *Table 4.4*). The low viscosity polymers eg starch and modified cellulose, are widely used as fluid loss reducers. Calcium and potassium ions and polymers are used as inhibitors to prevent well bore collapse during the drilling operations. In addition, lignin and ligno-sulphonates are used to prevent uncontrolled thickening of the drilling fluid during operations. To prevent biodegradation of the mud, a bio-degradable bactericide must be added. The precise composition of the WBDF will vary with depth of drilling.

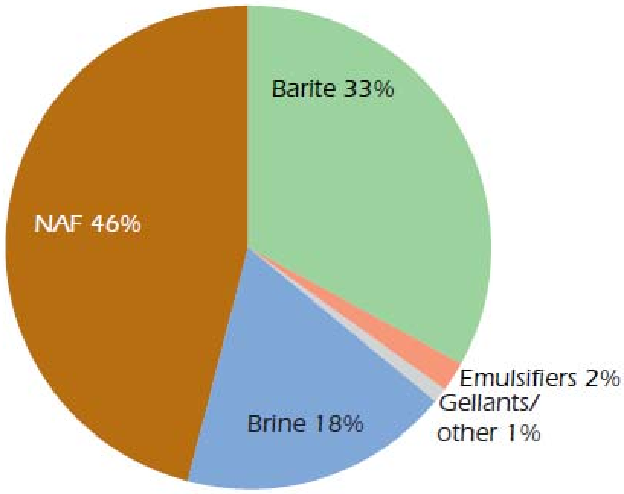
Table 4.4 Various other Drilling Fluid Components

#	Material	Use	Ecotoxicity
1	Caustic Soda	pH elevator	Soluble, non-toxic, 96 hr LC_{50} > 500 ppm
2	Lignite, lignosulphate	Deflocculant, viscosifier, seepage control	Soluble, non-toxic, 96 hr LC_{50} > 500 ppm
3	Sodium bicarbonate	Calcium build-up reducer	Insoluble, non-toxic
4	Organic synthetic polymer blends	Filtrate reducing agent	Non-toxic, 96 hr LC_{50} > 500 ppm
5	Aluminium stearate	Lubricant, defoamer	Non-toxic, insoluble
6	Diesel oil pill (< 0.1% mud volume)	Stuck pipe spotting fluid	Slightly soluble, 96 hr LC_{50} > 0.1 – 1000 ppm
7	Paraformaldehyde (0.1% mud volume)	Bactericide (biocide)	Non-toxic, insoluble
8	Gilsonite (asphalt-based)	Lubricant, fluid loss reducer	Non-toxic, insoluble
9	Glycol	Lubricant	Low toxicity

Non Aqueous Drilling Fluids

NADFs are emulsions where the continuous phase is the non-water dispersible base fluid (NDBF) with water and chemicals as the internal phase. The NADFs comprise all non-water and non-water dispersible base fluids. Similar to WBDFs, additives are used to control the properties of NADFs. A typical NADF composition is shown in *Figure 4.12*. Emulsifiers are used in NADFs to stabilise the water in oil emulsions. As with WBDFs, barite is used to provide sufficient density. Viscosity is controlled by adjusting the ratio of base fluid to water and the use of clay materials. The base fluid provides sufficient lubricity to the fluid, eliminating the need for lubricating agents.

Figure 4.12 Composition of Non-Aqueous Drilling Fluids



Source: After Melton *et al* 2000.

4.4 CEMENTING OF THE WELL CASING

Cement is required in drilling operations to fix the casings in the hole and prevent upward migration of hydrocarbons from around the outside of the well casing.

Cement is pumped into the well and up around the casing and typically sets in five to six hours. Though quantities are carefully calculated to ensure that all cement remains downhole, it is possible that a small quantity of cement may be released to the seabed when the first string of casings is cemented to the seafloor. In addition to basic cement, a number of additives are used to achieve the required performance properties of the cement. These include an antifoam and fluid loss agent, dispersant, bentonite, barite and calcium chloride.

4.5 DRILL CUTTINGS

During the drilling of a well, the major discharge from the drilling vessel is generally the drill cuttings. The quantities of drill cutting discharges expected are discussed under *Section 4.11.3*. Cuttings consist of crushed rock particles produced by the drill bit. They range in size from clay to coarse gravel (see *Table 4.5*). The composition of the rock particles reflects the types of sedimentary rocks penetrated by the bit, and most cuttings are expected to occur in the 0.25-0.70 mm grain size ie sand. Cuttings are generally considered to be relatively inert, depending on the drilling fluid used and the degree of cleaning but may contribute small amounts of trace metals and/or hydrocarbons to receiving waters (Neff *et al*, 1987). A curve indicating the size distribution of a typical drill cuttings discharge is given in

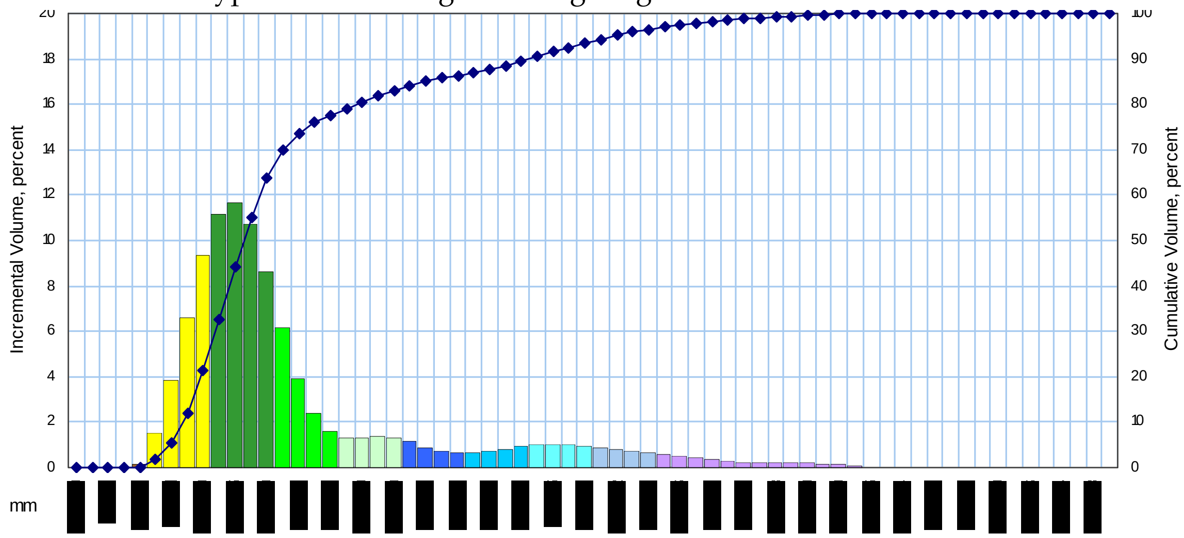


Figure 4.13. The size distribution of the cuttings discharge is expected to change substantially during the different stages of the drilling operation, as the well is drilled through the different geological strata.

Table 4.5 Grain Size Distribution of Drill Cuttings

Fraction of Cuttings	Substrate Classification	Grain size in microns	Grain size in mm	Volume
				%
		2000.00	2.00000	
		1414.21	1.41421	
		1000.00	1.00000	1.75
		707.11	0.70711	10.50
		500.00	0.50000	20.25
80%	SAND	**353.55**	0.35355	22.50
		250.00	0.25000	14.50
		176.78	0.17678	6.25
		125.00	0.12500	2.75
		88.39	0.08839	2.50
		62.50	0.06250	2.50
		44.19	0.04419	2.00
		31.25	0.03125	1.50
		22.10	0.02210	1.50
15%	SILT	15.63	0.01563	2.00
		11.05	0.01105	2.00
		7.81	0.00781	2.00
		5.52	0.00552	1.50
		3.91	0.00391	1.25
		2.76	0.00276	
		1.95	0.00195	
		1.38	0.00138	
5%	CLAY	0.98	0.00098	
		0.69	0.00069	
		0.49	0.00049	
		0.35	0.00035	

Fraction of Cuttings	Substrate Classification	Grain size in microns	Grain size in mm	Volume

Figure 4.13 Expected Grain Size Distribution of Drill Cuttings (G9A Temane-12 Sands size distribution - Sample Depth 1301.5 m MD after OMNI (2005))

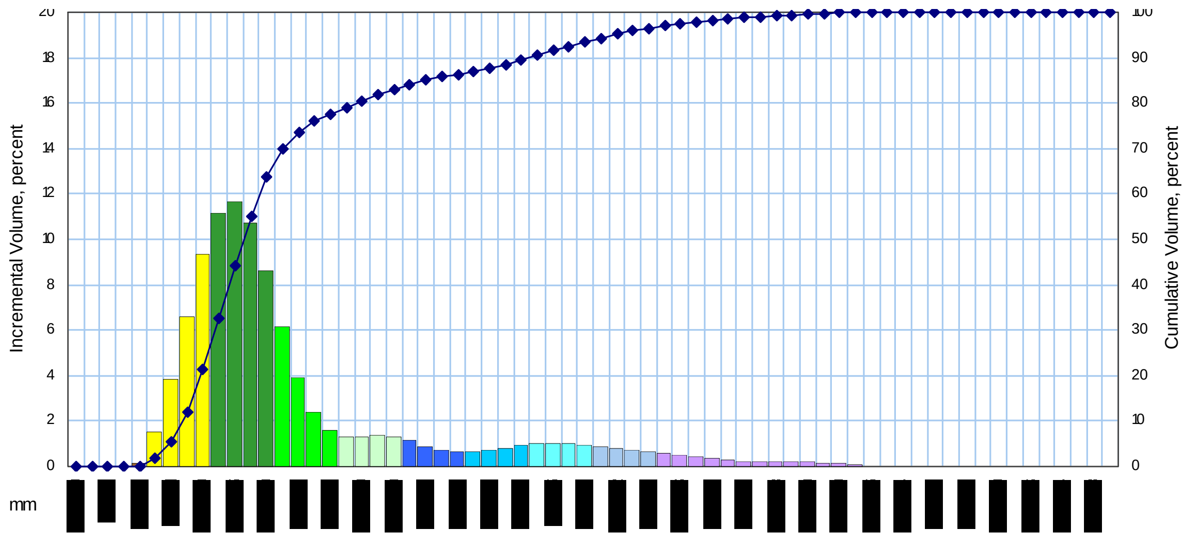


Table 4.6 Estimated Drill Cuttings Composition

Drill Cuttings Size Composition (% by Volume)			
Clay (4 µm)	Silt (4 – 62 µm)	Sand (62 – 2,000 µm)	Gravel (2,000 – 64,000 µm)
3.5	13.5	83	1

Note: Information based on previous drilling operations in this region (G9A Temane-12 sand size distribution - Sample Depth 1301.5 m MD after OMNI (2005). Previous studies in other regions have indicated that there may be a substantial variation in the drill cuttings composition over the various depth intervals.

4.6 FORMATION EVALUATION

A full mud logging service will be provided throughout the well by a third party contractor, which will include cuttings sampling and evaluation, gas measurement and 24 hour monitoring of most rig safety systems.

The detailed scope of the formation evaluation programme for the reservoir section will be developed during drilling operations based on the geology encountered, and is expected to include the following logs:

- Induction resistivity measurements
- Acoustic log
- Gamma ray, resistivity, neutron and density log
- Formation micro-resistivity measurements

- Downhole pressure measurements and samples
- Mechanical sidewall coring; and
- Vertical seismic profile (VSP)

Conducting specific evaluation logging requires the use of specialised wireline logging tools containing radioactive sources which are inserted in the wellbore by authorised personnel. Vertical seismic profiles require the placement of one or two airguns in the water as an energy source. The airguns used for a VSP are much smaller than those used in seismic operations and slow start ups are implemented to mitigate marine impacts. Transportation and storage of the radioactive material will be contained in service provider's company-approved containers. If, for any reason, a radioactive source in the logging tools become stuck and cannot be retrieved from the well hole, a cement plug of approximately 60m in length will be set above the source and a mechanical sidetrack will be drilled.

4.7 *WELL TESTING AND HYDROCARBON PROPERTIES*

Should drilling operations indicate the presence of hydrocarbons, a well production test may be performed. This will involve flowing hydrocarbons to surface by means of tubing or drill pipe under strictly controlled conditions for the purposes of fluid data measurement and sampling, as well as to assess the productivity of the formation. The hydrocarbons flowed to the surface will be disposed of by flaring through custom-made offshore burners and flares, which will ensure complete combustion.

Flaring is the controlled burning release of hydrocarbons, which takes place at the end of a flare stack or boom. The flare tip at the end of the stack or boom is designed to assist entrainment of air into the flame to improve burn efficiency. Seals installed inside the stack prevent flashback of the flame, and a vessel at the base of the stack removes and conserves any liquids from the gas passing through the flare.

The ability to test a hydrocarbon discovery is critical in securing valuable information that will determine whether the discovery is commercially viable or not. Well testing operations are of short duration (estimated at a maximum of three days of flow per well) and are of a temporary nature with no lasting impacts on the environment.

The primary target hydrocarbon resource for the exploration project is believed to be natural gas. Condensate, a hydrocarbon liquid, often occurs in association with natural gas. Properties for condensate in the area, provided by SPSL and used in the oil spill modelling study, indicates it to have a density of 0.74 g/cm^3, a viscosity of 0.767 cP, an API gravity value of 60, and a surface tension value of 18.4 (dyne/cm). Viscosity and interfacial surface tension determine the spreading of surface oil, and influences the rates of evaporation, dissolution, dispersion and photo-oxidation in the event of a spill or blow out.

4.8 *WELL ABANDONMENT AND WELL SUSPENSION*

Based on the results of the drilling, evaluation and possible testing of the well, a decision must be made as to the final state the well will be left in before the drilling vessel is moved off location.

On completion of the well testing, wells will be abandoned or suspended according to international best practice. The well will be abandoned unless hydrocarbon production is prolific, in which case, the well will be suspended to allow further work to be carried out at a later stage.

Well abandonment involves completing the well with cement plugs and removing all wellhead equipment to leave the seafloor free of all equipment. The steel casing will be severed below the mud-line to leave no protrusion on the seafloor.

If the well is suspended, it will be completed with cement plugs, and subsea equipment will be left on the seafloor. A corrosion cap and cage will be placed on the wellhead and left in place to facilitate re-entry at a later stage. The complete wellhead assembly will protrude approximately five meters above the seafloor. A schematic of a suspended wellhead and an abandoned wellhead is provided in *Figure 4.14* and *Figure 4.15*, respectively.

An exclusion zone of 500 m will be required around the suspended well in which no trawling is permissible and wells will be marked on Notices to Mariners.

Figure 4.14 Suspended Well Schematic

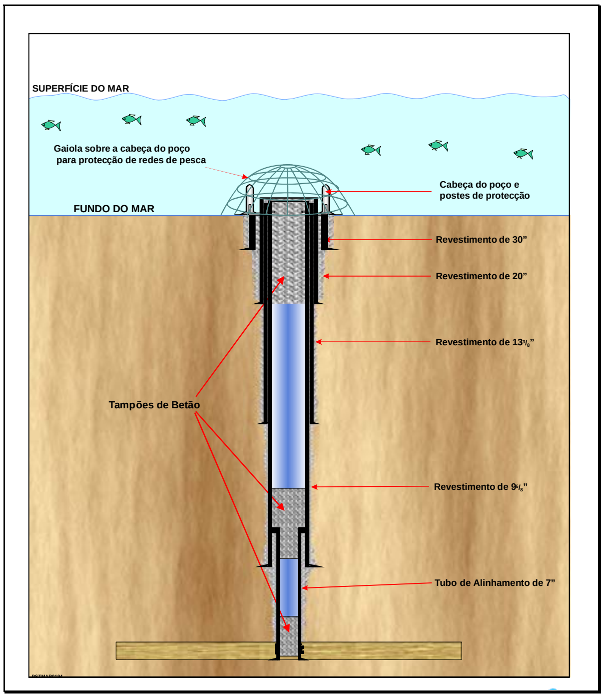
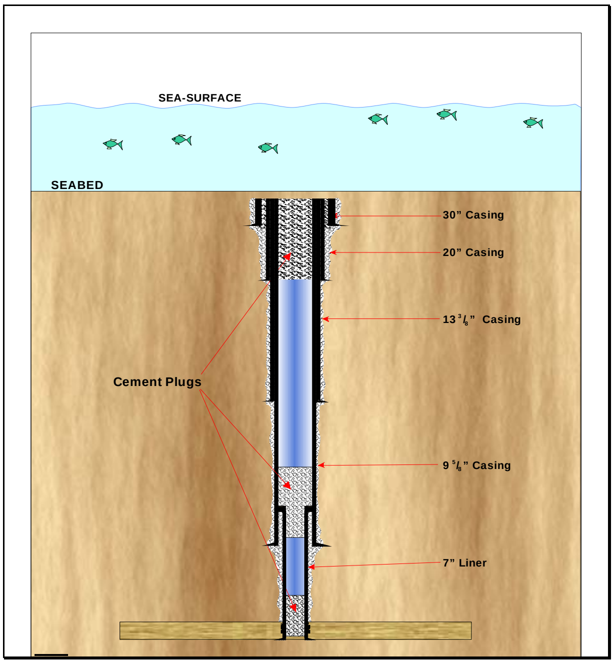


Figure 4.15 Abandoned Well Schematic



4.9 SAFETY STANDARDS, EXCLUSION ZONES AND MARITIME COMMUNICATIONS

The contracted drilling vessel(s) will be certified for seaworthiness through an appropriate marine certification programme, such as Det Norske Veritas or similar. Safety certificates and vessel specifications will be made available to the National Petroleum Institute five weeks prior to the start of the activities, once the preferred drilling contractor has been confirmed.

While the drilling vessel is operational, a temporary 500 m statutory exclusion zone around the vessel will be in force. The total area of this exclusion zone is thus 0.8 km^2.

Standard communication procedures will be undertaken to ensure all vessels active in the area are informed of the drilling activities. This will take the form of notifying all relevant institutions such as INAHINA and INAMAR, which will transmit the information to other ships entering the area. A support vessel will be circulating around the exclusion zone to inform artisanal fishermen and other vessels that may approach the area to stay outside of the defined exclusion zone. The drill vessel will also be illuminated and visible at night.

4.10 DRILLING SUPPORT AND RESOURCE REQUIREMENTS

The majority of the resources (eg equipment, materials and staff) required to drill offshore exploration wells will be sourced from the global international market. Opportunities for local participation are likely to be limited to onshore support services such as supply base services, catering, water and fuel supply. Such services will be tendered and service providers required that meet minimum requirements.

4.10.1 Personnel

The drilling rig will come self-contained with a highly trained and specialised work force. Accommodation will be supplied on the drilling vessels which will cater for two drilling shifts working on a 12-hour basis, as well as for daily operational and maintenance staff requirements. All other drilling support technical services will also be accommodated on-board. The total work force on the drilling vessel will depend on the specific vessel's accommodation capacity but is likely to range between 80 to 100 people. Additionally, support vessels will be operating with approximately 10 people each. Personnel will be accommodated at hotels in Beira on a rotational basis.

Internationally resident drilling services personnel will normally work on a rotational basis. They will be transferred to and from the drilling vessel via a helicopter and/or boat service located at Beira´s Airport and/or Port (*Figure 4.16*).

4.10.2 *Logistics Support and Services*

An onshore logistics base and lay down area will be located at the Port of Beira where materials and equipment will be stored and supplied to the offshore operations (see *Figure 4.16*). Two supply vessels will serve the drilling vessel. One will typically be kept on 24-hour standby near the drilling vessel and the second vessel will shuttle from the drilling vessel to the logistics base to remove waste and unused equipment and to fetch fresh supplies. A supply vessel is expected to travel between the logistics base and drilling vessel every two days for the duration of the drilling programme.

The personnel transportation to/from offshore and the evacuation services (Medivac) will be done through helicopter services or by boat. It is anticipated that one helicopter trip might be undertaken daily, under normal conditions.

4.10.3 *Fuel Requirements*

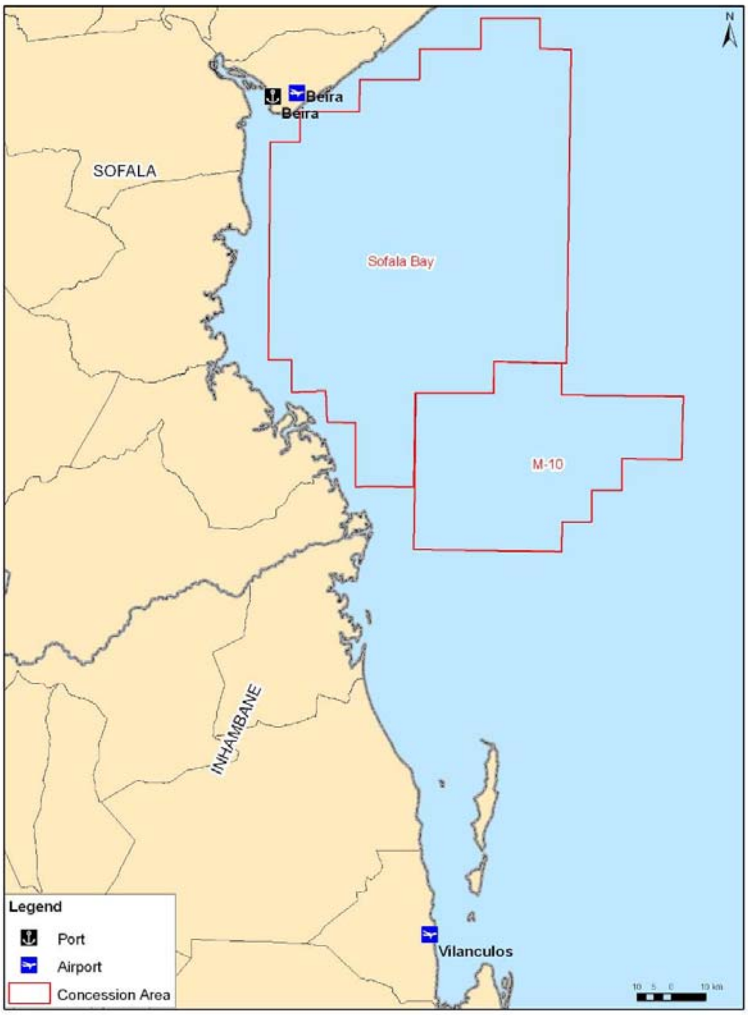
Diesel and potentially Heavy Fuel Oil (HFO) may be used as fuel for the vessels. The following oil types and associated properties have been assumed for the proposed project:

- Diesel: The assumed diesel fuel oil properties are those for the oil type 'Fuel Oil No. 2, synonym Low Sulphur No. 2 Diesel Fuel Oil' obtained from the ADIOS (2000) database.

- Heavy Fuel Oil: The assumed heavy fuel oil properties are those for the oil type 'Fuel oil No. 6, synonym Bunker C' obtained from the ADIOS (2000) database.

Refuelling of the drill rig will be required approximately every four days to maintain maximum storage during which 1,000 to 1,500 bbls of diesel will be transferred by bunkering from a supply vessel.

Figure 4.16 Logistics Map Illustrating Support for Off-shore Drilling Vessels



4.11 *Operational Discharges and Waste Management*

This section covers the anticipated waste and emissions that will be generated by the drilling activities, and the minimum requirements for minimising pollution risks arising from waste generation. Waste management measures for drilling will be described in a Waste Management Plan that is a requirement of the Environmental Management Plan (EMP) for the planned exploration activities.

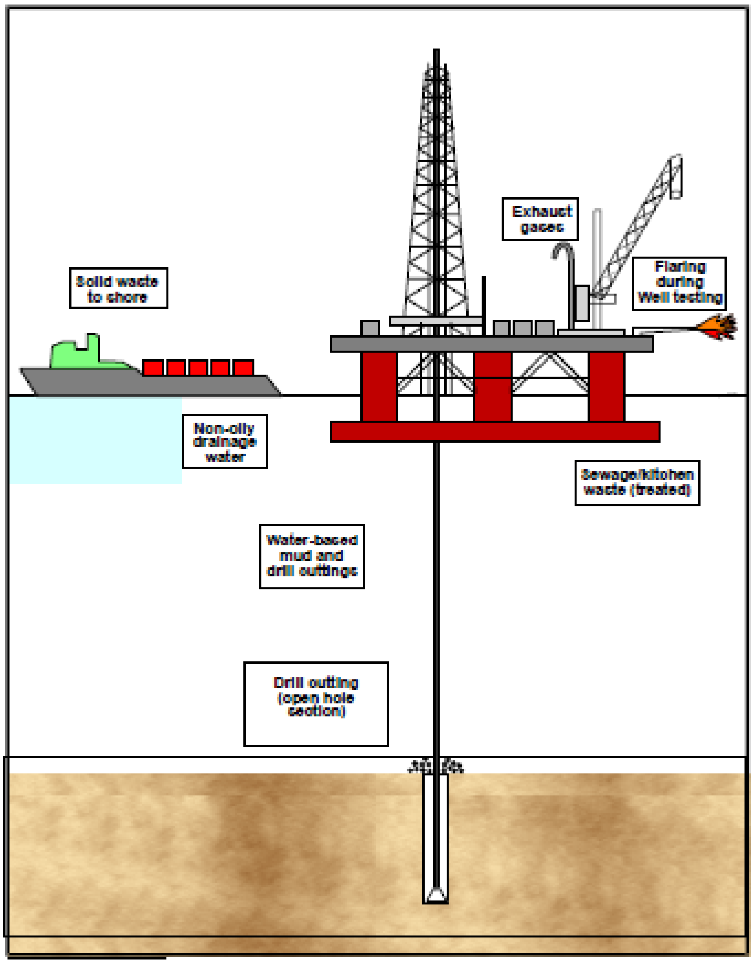
The EMP will become a critical part of the Drilling Programme and the Waste Management Plan will be designed to ensure that any adverse effects from drilling and well testing operations on the marine and near-shore environment are minimised or avoided.

Waste components generated during the proposed project will include:

- Drilling cuttings and fluid
- Cement and cement additives
- Deck drainage
- Macerated or treated sewage
- BOP hydraulic fluids
- Vessel machinery spaces and ballast water
- Food (galley) macerated wastes
- Detergents
- Emissions from generators and other machinery

The principal wastes and emissions from an offshore drilling operation are illustrated in the schematic drawing in *Figure 4.17.*

Figure 4.17 Schematic showing Waste Components from Generalised Drill Rig



Note: the diagram is not specific to the jack up drill rig proposed for this drilling campaign, but shows waste types for generalised drilling programme.

4.11.2 *Emissions to Air*

The main emissions to the atmosphere from the drilling vessel will be from the exhausts fitted to the diesel power generators, which will be in operation 24 hours a day. Emissions from the generators will comprise conventional combustion products ie mainly CO_2 and water vapour, with lower concentrations of NO_2, SO_2, unburned hydrocarbons and particulates. The concentration of SO_2 in the exhaust gas will depend on the fuel source. Use of low sulphur diesel will minimise SO_2 emissions. Manufacturer's instructions for the operation and maintenance of the equipment will be followed to ensure that equipment operation is carried out at the highest possible level of efficiency.

4.11.3 *Discharges to Sea*

Drilling Cuttings and Drilling Fluid

Typical drilling fluid requirements and discharges for 5,000m well depth are provided in *Table 4.7.* NADF will be recycled and ultimately returned to the suppliers. However, a portion of the fluid adhering to the drilling cuttings will be discharged to sea. The rig will use solid control equipment to minimise the amount of drilling fluid on cuttings. SPSL is committed to continuous improvement by enhanced cuttings treatment to reduce oil on cuttings to less than 5% as a weighted average.

The total volume of cuttings to be discharged from each deep well (drilled to 5,000 m) is expected to be 505 m^3) of which 249 m^3) will come from the 'top hole' (36", 26" and 17.5" sections) and 256 m^3 from the 'bottom hole' (12.25" and below). Cuttings will be released near the sea surface except for that generated during drilling of the top 36" section of the well.

Table 4.7 Expected Drilling Program Discharges for a 5,000 m well

Drill section	Diameter (inches)	Depth (m)	Cutting Vol (m^3)	Mud Vol (bbl)	Drilling Mud Type	Discharge Level
1	36	100	67.57	1,100	WBDF	Seabed
2	26	200	69.95	3,300	WBDF	Surface
3	17.5	700	111.29	2,700	WBDF	Surface
4	12.25	2500	198.73	65	NADF	Surface
5	8.5	1500	57.24	20	NADF	Surface
	Total	**5,000 m**	**504.78 m^3**	**7185 bbl**		

Cement and Cement Additives

The bulk constituents of the cement system are predominantly non-toxic. No cementing chemicals will be released into the environment as they will remain in a closed system down hole.

Deck Drainage

The drilling vessel will have a closed drain system, designed to collect spillages and wash-down from drip trays located underneath equipment and drain gutters from lay down areas. Hazardous and non-hazardous area open drain headers will be provided to ensure segregation between the two different areas. Water wash-down and rainwater will be routed directly overboard. Water drainage from the drill deck will be controlled to prevent discharge of untreated water overboard. Any oily water that does not meet MARPOL standards for discharge will be stored in drums in a bunded area for onshore disposal at an appropriate facility.

Sewage

Drilling units of the type being considered for this project typically house about 80 personnel. Based on previous experience, the sewage system will be required to handle 204 litres/person/day. For an average 50-day operation, this amounts to 816,000 litres discharged from the sewage system. MARPOL [(1)] Annex IV requires that sewage discharges from ships be treated and disinfected in a sewage treatment plant or through a comminuting and disinfecting system, and cannot be discharged within three nautical miles of nearest land. The sewage effluent must not produce visible floating solids in, nor cause discolouration of, the surrounding water. Sewage which has not been comminuted (reduced to small particles) or disinfected can only be released into the sea beyond 12 nautical miles. The discharge depth is variable, depending upon the draught of the rig at the time, but should not be less than five metres below the surface.

4.11.4 Land Disposal

The following types of wastes are expected to be disposed of at an appropriate location and in accordance with the waste management plan which is specified as a requirement in the Environmental Management Plan:

- Garbage
- Scrap Metal and Other Material
- Drums and Containers
- Used Oil
- Chemical and Hazardous Waste
- Laboratory Waste
- Infectious Waste
- Filters and Filter Media

(1) Convention for the Protection of Pollution from Ships (MARPOL) places restraints on the contamination of the sea, land and air by ships. Annex IV specifically relates to prevention of pollution from sewage.

Scrap metal and other recyclable waste, such as glass and hard plastic, will be stored and transported to a recycling location in Maputo or Beira. Waste oil and other hazardous waste will be stored in drums in bunded area and will probably be disposed of to the hazardous waste site in Maputo (operated by EnviroServ). Specific measures for dealing with different waste types will be detailed in a Waste Management Plan, required under the EMP provided in Section 10.

5 ASSESSMENT AND COMPARISON OF ALTERNATIVES

5.1 TYPE OF ALTERNATIVES CONSIDERED

The assessment of alternatives has included consideration of the following:

- Variations related to location of well sites;
- Location alternatives for the onshore logistics base;
- Alternative Technology;
- Timing for the project proposed;
- Alternative disposal methods for disposal and treatment of drill cuttings.

Alternative technologies considered for the proposed exploration project include drilling fluid types, and cuttings treatment and disposal options. These alternatives as well as the No-Go alternative are discussed below.

5.2 NO-GO ALTERNATIVE

Consideration of the No-Go alternative requires evaluation of the consequences of not pursuing the proposed offshore exploration well drilling and well testing activities in the Sofala Concession. This No-Go alternative will have both positive and negative effects.

Should the proposed exploration activities not go ahead, the obvious consequence is that there will be no potential negative impacts on the marine environment and no subsequent potential negative impacts on artisanal and industrial fishing or tourist-related activities.

The negative effects of the No-Go alternative are related to the missed opportunity costs of potentially exploiting a natural resource than can provide significant foreign exchange income and gas supplies for industrial and household development in Mozambique. Should no exploration activities be allowed to take place, the Government off Mozambique will not be able to realise this benefit.

Major oil and gas resources are currently unexploited in developing or emerging economies, due to lack of access to viable commercial markets. Should viable gas reserves be discovered under the proposed exploration drilling, subsequent development of these reserves will have the potential to bring substantial economic benefits to Mozambique. The development of an offshore gas reserve is likely to generate government revenue, add to the county's Gross National Product, create job opportunities and generate foreign exchange. However, realising these benefits for local communities will require government commitment to ensuring that a significant portion of revenues is invested in social and infrastructural development of the Sofala and Inhambane Provinces. If the project is successful, it is anticipated that SPSL will continue to invest in social development projects in the provinces where gas activities are taking place.

Sustainable development in the context of Sofala bay would depend on an understanding of the necessary trade-offs in various economic sectors to ensure that the development of one sector eg oil and gas industry, does not significantly compromise the development of other important sectors eg fisheries.

Table 5.1 Disadvantages and Advantages of the No-Go Alternative

Disadvantages	Advantages
Missed opportunity to develop potential offshore gas resources in the concession and to generate additional revenue for the Government of Mozambique. Potential revenues could be significant and if used wisely could be invested into the local economy to improve social and infrastructural development, and alleviate poverty, in the Sofala / Inhambane Provinces.	The status quo of the existing biophysical and socioeconomic environment status quo is maintained and allowed to follow its natural course in the absence of potential risks posed by the drilling project, eg sedimentation and noise effects on fisheries and other marine fauna, or in the event of an emergency blow out of condensate.

5.3 DRILLING ALTERNATIVES

5.3.1 Variations Related to Location and Depth of Well Sites

The location of the two well sites and the depth of drilling required is determined solely on the potential viability of the resources in the deeper geological strata. Selection of drill sites is therefore done based on the results and analysis of seismic surveys. Should a situation arise where it appears that a well would have an equal chance of similar yields in more than one location within the concession then criteria such as proximity to key fishing areas and distance to shore could be considered as factors influencing the exact drilling position. In such a situation, the priority will be to stay as far as possible away or down-current of prime fishing grounds and from sensitive coastal areas.

5.3.2 Timing of Drilling Activities

Drilling is scheduled for some time between March and November 2011 and expected to take 40-45 days per well and a further 10-15 days of well testing. The timing of drilling activities must avoid the cyclone season between December and February. Timing outside of the cyclone season ultimately depends on the availability of a suitable drill rig. However, the fishing lobby has motivated that the timing is scheduled after June to avoid the peak prawn fishing season. Therefore the key window of opportunity would be the six - month period between June and November.

5.3.3 *Location of the Onshore Logistics Base*

Beira is the obvious choice for the onshore logistics base for the drilling programme due to its proximity to the concession area and its available infrastructure and facilities that can support the drilling operations. There are no viable alternatives to the use of Beira, nor reason to consider an alternative onshore logistics base.

5.3.4 *Alternative Drilling Rigs*

The evaluation of alternative drilling vessels is largely determined by their operational requirements, particularly their suitability under different environmental conditions, such as water depth among other factors. The alternative drilling vessels are not expected to differ significantly in the type and magnitude of impacts. Alternative drilling vessels have therefore already been assessed and the jack-up rig was selected as the best option since these rigs are used in shallower water up to approximately 100 m in water depth, and can therefore be used for both the shallow and deeper water prospects.

Description of Drill Rig Options

Drill rig alternatives can be separated into those used for deepwater drilling and those used for shallow water drilling.

Deepwater drill vessels include:
- Semi-submersible drilling vessel
- Drill ship

Shallow-water drill vessels include:
- Jack Up Drill Vessel
- Drill Barge

Each of these types is discussed in turn.

Deep Water Drilling Vessels

Semi-submersible rig:
A semi-submersible drilling vessel (rig) is essentially a drilling rig with auxiliary drilling and marine support equipment located on a floating structure that is comprised of one or a number of pontoons (see *Figure 5.1*). When at the well location, the pontoons are partially flooded (or ballasted), to submerge the pontoons to a pre-determined depth below the sea level where wave motion is minimised. This gives stability to the drilling vessel to enable drilling operations to proceed.

A semi-submersible rig normally requires a tow vessel or transport barge to transport the vessel to its drilling location. The semi-submersible uses riser pipe on compensated hydraulic tensioners (which keep the tension of the riser pipe constant during wave motion), to connect the vessel to the seabed and to act as a conduit through which drilling operations can proceed and drilling fluid can be circulated.

The wellhead or top part of the well will be located on the seabed, where the pressure integrity and control of the well during drilling operations is ensured by the deployment of a sub-sea Blow-Out Preventer (BOP) which is latched onto the top of the well head.

Figure 5.1 ***Semi-submersible Drilling***

Drill-ship:
A drill-ship is essentially a self sufficient ship (see *Figure 5.2*) with a drilling rig attached, normally located at the centre of the ship where drilling operations are conducted through a partition in the hull known as the "moonpool". The advantages of a drill ship over a semi-submersible rig are that the drill ship has much greater storage capacity and is independently mobile, not requiring any towing or transport vessel.

Like the semi-submersible, the drill-ship uses riser pipe on compensated hydraulic tensioners to connect the vessel to the seabed and to act as a conduit through which drilling operations can proceed. The wellhead or top part of the well will be located on the seabed, where the pressure integrity and control of the well during drilling is ensured by the deployment of a subsea BOP which is latched onto the well head.

Figure 5.2 *Typical Drill Ship*

Shallow Water Drilling Vessels Alternatives

A jack-up or barge type drilling vessel is required for the drilling of the Shallow Water Prospect.

Jack-up Drilling Vessel:
A Jack-up drilling vessel is a mobile, self-elevating drilling platform with legs that can be lowered to the sea bed (see *Figure 5.3*). With the legs secured on the seabed, the drilling vessel provides a secure platform for drilling operations to proceed, as well as to provide onboard accommodation for all operational personnel requirements. A comprehensive survey of seabed conditions beneath the feet of a jack up rig will be conducted to ensure the rig is securely established.

The wellhead arrangement for a jack-up drilling vessel will be on the surface like a land operation. The BOP will also be located on the surface, being latched onto the top of the wellhead. In the absence of deploying well control equipment on the seabed, operations are much simpler than for the floating vessels. A jack-up is normally cheaper to operate than a floating vessel. However, the transport of a jack-up may involve the use of a specialised transport vessel which is in global short supply.

Jack-up rigs are limited for use in water of 20 m to 100 m depth.

Figure 5.3 *Typical Jack up Drilling Vessel*

Drill barge:
Drill barges (see Figure 5.4) are generally utilised in shallow water lake or swamp environments. They consist of a drilling rig and associated equipment located on a barge vessel which is towed onto location and ballasted down to sit on the seabed. Drilling operations are then conducted from the barge, similar to any land drilling operation. Because of the extremely shallow waters of this Shallow Water Prospect Area, a drill barge will be reviewed as an option.

Figure 5.4 *Typical Drill Barge*

In summary, the environmental implications of the various rigs are not a significant determining factor in selecting the preferred rig alternative. The preferred option of using a jack up rig can be used in both the shallow water and deeper water (at depths up to 100m), and is the most cost effective rig option.

5.3.5 *Drilling Fluid Use Options*

Two main drilling fluid types are commonly used in offshore drilling: Water Based Drilling Fluids (WBDFs) and Non-Aqueous Drilling Fluids (sometimes referred to as Low Toxicity Oil Based Muds (LTOBMs)). The latter type include base oils refined from crude oil which form the continuous phase of the mud, while WBDFs contain water (up to 90% volume) as the continuous phase. WBDFs are generally recommended for use over NADFs (or LTOBMs) where feasible and particularly in ecologically sensitive areas as they are less toxic to marine organisms. In some geological formations that are water sensitive, such as in clays and shales which are prone to swelling, use of WBDFs can cause an increase in 'stuck pipe' or increased risk of hole collapse. In these situations, NADF or LTOBMs are preferred for drilling the deeper sections of a well to avoid these potential problems. Thus, where the geological strata are suitable WBDFs are the preferred drilling mud. However, problems with using WBDFs were experienced in Concessions 16 and 19, and given the likely similar geological strata in the Sofala Concession, a combination of WBDFs and LTOBMs or Group III NADF with low aromatic content have been chosen as the preferred drilling mud. Formulation of the NADF will depend on the well conditions but generally require a different oil/water ratio, and other additives. The options are compared and summarised in *Table 5.2*.

Table 5.2 ***Disadvantages and Advantages of Drilling Mud Alternatives***

	Disadvantages	Advantages
Water Based Drilling Fluids	Not suitable for use where shale and clays in well profile may swell and cause well collapse	Low toxicity to the marine environment, and easily biodegradable with little residual effect
Non Aqueous Drilling Fluids	More toxic to marine fauna than WBDFs, with some residual effects eg lower benthic fauna diversity in the 500-1000m zone around a well site	Better suited to drilling in the offshore environment where clays and silts prevalent to avoid swelling, drill string sticking and possible well collapse.

5.3.6 *Drill Cuttings Disposal Options*

A Best Practicable Environmental Option (BPEO) study was undertaken to assess cuttings disposal options. No disposal option appears to be associated with widespread and irreversible environmental impacts. For offshore drilling, the industry has developed drilling fluids that minimise the environmental impact of the discharged cuttings.

Options that have been considered include:
- Reinjection of drill cuttings
- Transport and onshore disposal
- Treatment and disposal to sea (after oily content minimised)

Re-injection of drill cuttings from floating installations does not appear to be technically feasible as no disposal wells are currently available for reinjection, although this technology may show promise in the future as the industry in Mozambique develops further. Re-injection would depend on the availability of suitable geological conditions.

Although transport of cuttings to shore for treatment and/or disposal or alternative use is an option, there is presently no infrastructure within Mozambique to accommodate all the cuttings that would be generated offshore. The transport of cuttings to shore would increase emissions to atmosphere and also pose risks associated with personnel and community safety, and soil and groundwater contamination.

Disposal to sea after treatment and drying to reduce the oily content to less than five percent weighted average is a commonly applied solution to drill cutting disposal and is the most viable option for this drilling project. See *Section 4.2.4* and *Section 4.3* for a more detailed description of drill cuttings treatment and drill fluids.

All three options have their trade-offs in terms of environmental impacts and costs. It was proposed that cuttings be discharged to sea and that a process of continuous improvement be applied to cuttings cleaning prior to discharge.

Alternative disposal options are compared in *Table 5.3* with the key considerations outlined in the comparative assessment.

Table 5.3 Comparative Assessment of Drill Cutting Disposal Options

Criteria	**Onshore Disposal**	**Re-injection**	**Offshore Discharge**
Environmental and Social Factors	• Marine impacts: increased vessel movements with potential increased collision risks. • Potential onshore impacts: air emissions and soil / water contamination risks	• No marine or terrestrial impacts	• Potential short-term impact on benthic communities
Cost	• High cost	• High cost	• Low cost

Criteria	Onshore Disposal	Re-injection	Offshore Discharge
Safety	• Increased safety risk	• Safety risk due to high pressure injection system	• Low safety risk
Technical	• No onshore disposal facility available.	• No re-injection well available	• Technically uncomplicated and feasible disposal method. Technology available to clean cuttings.
Summary	**Not feasible**	**Not feasible**	**Feasible**

Section 3

Environmental and Social Baseline

Chapter 6: Environmental Baseline: Biophysical

Chapter 7: Environmental Baseline: Socio-Economic

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SECTION 3: CONTENTS

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6 BIOPHYSICAL BASELINE

6.1 INTRODUCTION AND DEFINITION OF THE PROJECT AREA

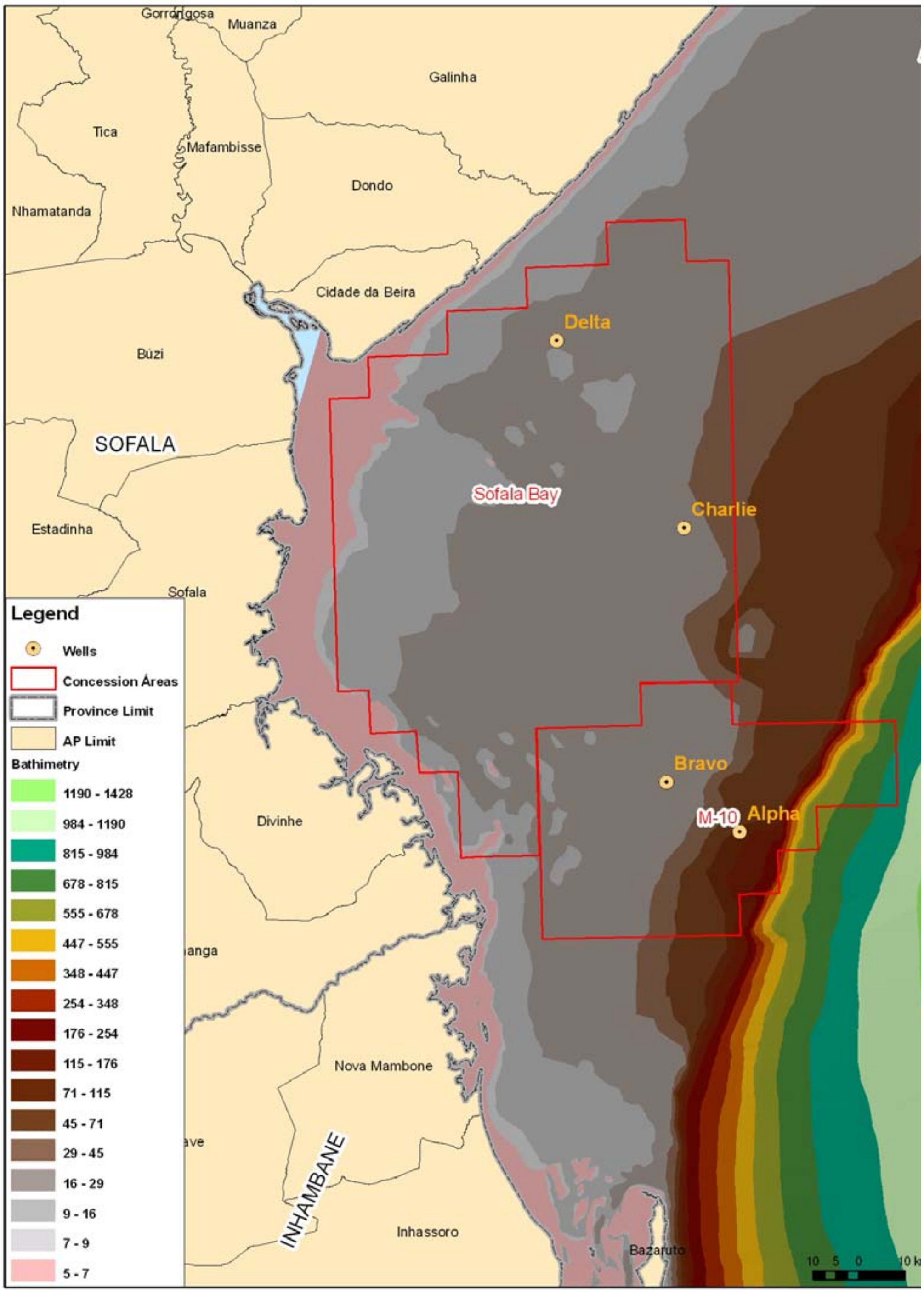
The proposed exploratory drilling will be conducted within the Sofala Concession. The description of the study area covers the whole concession and the coastline between the Bazaruto Archipelago to the south and northwards to the Beira and Dondo area, south of the Zambezi River. It includes the Sofala Bank (1) . The precise locations of the drill sites are not known and will be confirmed after further seismic analysis, but approximate positions supplied by Sasol Petroleum Sengala Limitada (SPSL) are marked on *Figure 6.1*. Any changes to these positions are not expected to influence the defined Project Area as presented in the biophysical and socioeconomic baseline descriptions.

The Project Area encompasses the drilling concession area, in which the direct impacts of the project would occur to a greater degree, and a broader area, extending to the coastline of Sofala and Inhambane Provinces which could be influenced either by drilling support activities or if an emergency event should arise (eg oil spill from a vessel collision; or uncontrolled release of condensate).

The following sections present a description of the study area focussed primarily on features or aspects of the biophysical and socioeconomic environment that may be influenced by project activities or that may influence the outcome of project activities (eg current and wind speed influencing drill cutting dispersions). The information presented here has been drawn from the specialist studies undertaken during this EIA but also from a number of environmental and research studies undertaken in the region of the concession. These include seismic acquisition and drilling studies (Impacto 1998, 2000 and 2007), a study for Petronas´s Zambezi Concession (Impacto, 2007), and for Sasol´s Concessions 16 and 19 near Bazaruto Archipelago (ERM and Consultec, 2006), located south of the project area.

(1) The Sofala Bank is located between Angoche (16º 20´S) and the mouth of the Save River (21º 00´S). It extends offshore the southern part of Nampula Province as well as Zambézia and Sofala Provinces. This is one of the most important fishing grounds of Mozambique.

Figure 6.1 Map Showing Location of Sofala and M-10 Concessions in Relation to Bathymetry



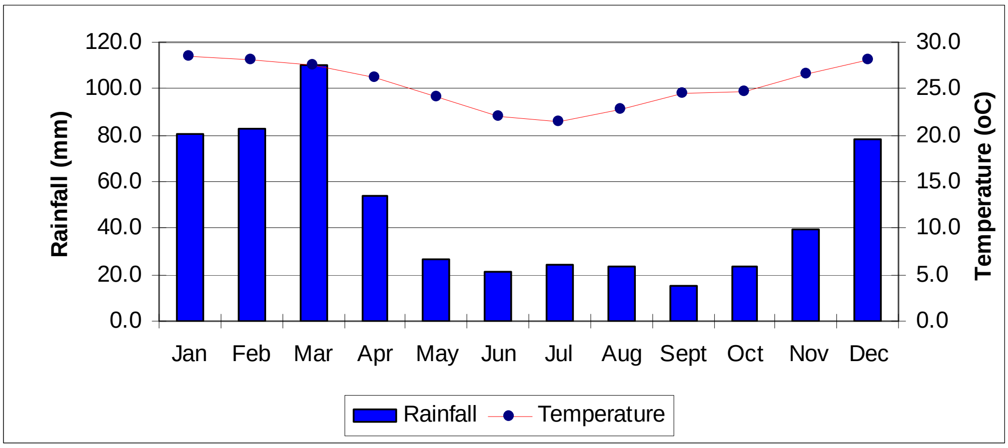
6.2 CLIMATE

The following section on climate has been referenced from Impacto (2005), Impacto (2007) and ERM and Consultec (2006). The information related to cyclone occurrence in the study zone has been updated with more recent 2010 data from the National Meteorological Institute (INAM).

6.2.1 *Precipitation*

Precipitation occurs in every month of the year, but there are two distinct climatic seasons in the coastal areas of the Project Area: the hot rainy season from December to March and the colder dry season from May to November. Average annual precipitation is 1338 mm and average annual temperature is 24.9°C for Beira (Impacto, 2007) – the meteorological station closest to the concession. Peak monthly rainfall occurs between December and March (*Figure 6.2*).

Figure 6.2 Average Monthly Rainfall and Temperature at Beira for 1968 to 2000.

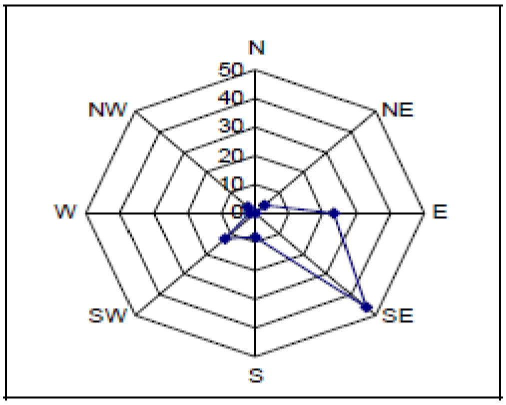


Source: Institute for Meteorology (INAM)

6.2.2 *Wind*

The wind regime in the north of Mozambique is influenced by the monsoon system with a predominance of a north-east wind in summer and south-west in winter. Statistics for Beira Airport from 1961 to 2005 indicate a predominant southeast wind direction (46 percent), and, in decreasing order, from the east quadrant (23 percent), southwest (13 percent) and south (8 percent) (*Figure 6.3*). Tinley (1971) describes a strong land-sea breeze system in the study area, with winds predominantly from the south during the morning, swinging to predominantly easterly during the afternoon.

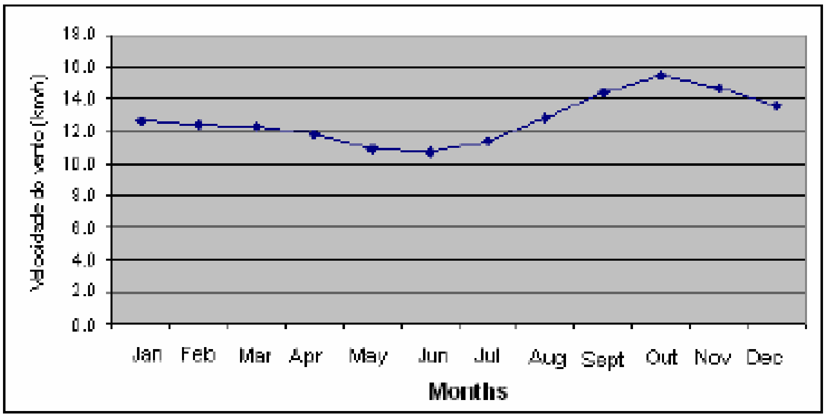
Figure 6.3 *Wind Rose Data for Beira Airport from 1961-2005*



Source: National Institute of Meteorology (INAM)

Average annual wind velocity in the study area has been recorded as 12.7 km/h, with a minimum average value in the month of June (10.7 km/h) and maximum average observed in the month of October measuring 15.4 km/h (*Figure 6.4*). However, between 1961 and 2005 the highest monthly average wind velocity reached a value of 19.5 km/h in the month of September 1972. Offshore winds speeds are generally higher than those measured on land.

Figure 6.4 *Average Monthly Wind Velocity for 1961 to 1990 at Beira Airport*



Source: National Institute of Meteorology (INAM)

6.2.3 Cyclones

According to Tinley (1971), the mean occurrence of cyclones in the Mozambique Channel is just over three per annum. The National

Meterological Institute classified the study area as one of higher risk for tropical cyclones, as represented in *Figure 6.5* below.

Between 1958 and 2008, 30 cyclones struck the Mozambican coast affecting mainly the central sector of the coastline and bringing torrential rains, flooding and severe wind damage (see *Figure 6.6*). In 2003, the Sofala region, where the drilling concession is located, was affected by two cyclones - Delfina (January 2003) and Japhet (March 2003), which caused considerable coastal damage. Japhet was classified as a Category 4 cyclone, with wind speeds ranging between 230 and 280 km/h. More recently, in 2007, cyclone Favio struck the coast near the project area and affected parts of Inhambane and Sofala Provinces. Peak cyclone season tends to be between November and March.

Between 1975 and 2006 there were three Category 4 cyclones (Intense Cyclone) and five Category 3 cyclones (Tropical cyclones). Categories of severity established by INAM are defined in *Table 6.1*.

Table 6.1 ***Tropical Cyclone Classification according to the Operational Plan for the Southwest of the Indian Ocean by the World Meteorology Organization***

Category	**Name**	**Maximum Wind Speed (km/h)**	**Gusts (km/h)**
1	Moderate Tropical Storm	63-88	90-124
2	Severe Tropical Storm	89-117	125-165
3	Tropical Cyclone	118-165	166-233
4	Intense Tropical Cyclone	166-212	234-299
5	Very Intense Tropical Storm	More than 212	300 or more
Source: INAM 2006			

Figure 6.5 Frequency of Cyclones per District Along the Mozambican Coast

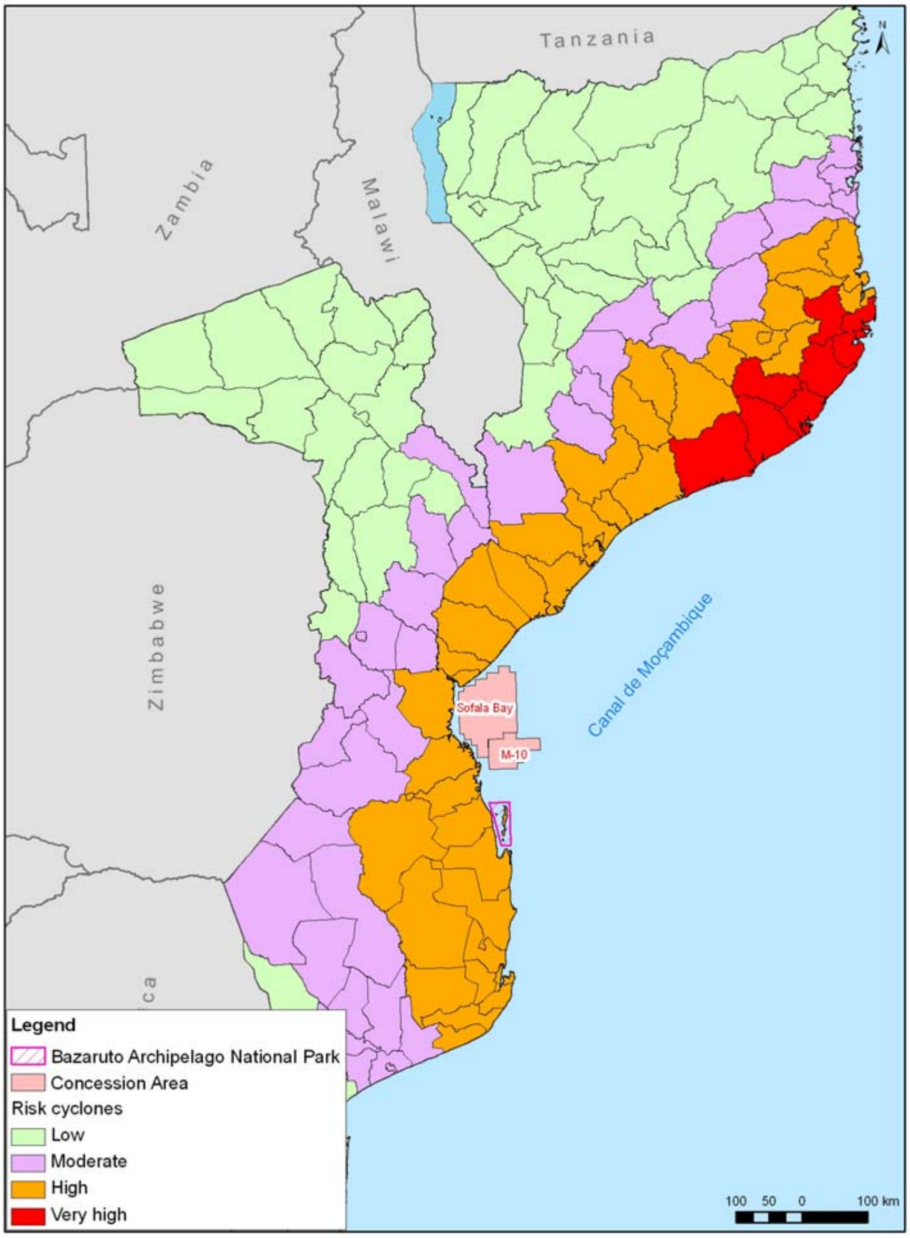
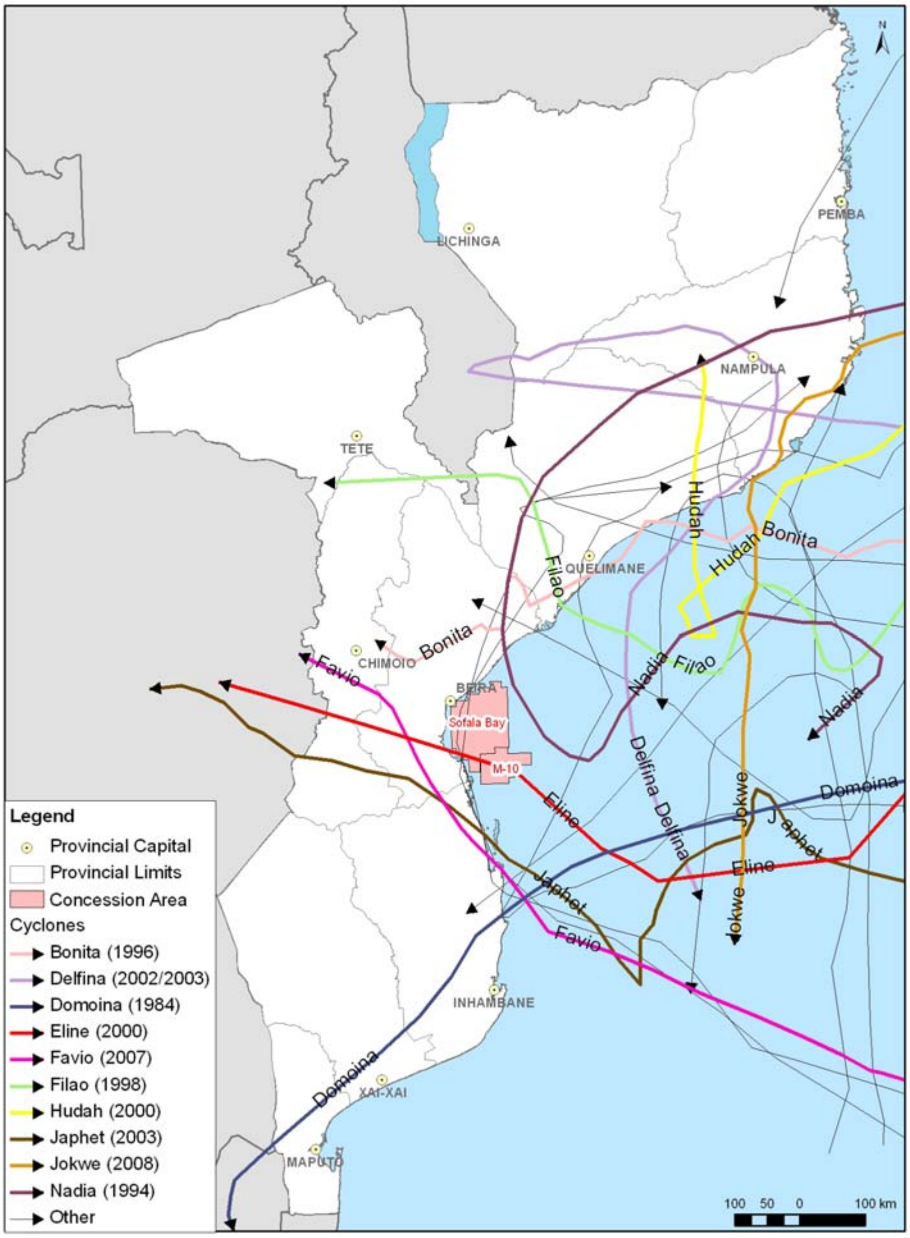


Figure 6.6 Cyclones Making Landfall Along the Mozambican Coast (1958 to 2008)



6.3 *PHYSICAL OCEANOGRAPHY*

Information on the physical oceanography of the study area has been extracted from the ERM and Consultec Report (2006 and 2008) for the Sasol Natural Gas Project, which focused on the Bazaruto Archipelago area but also extended into Sofala Bay. Other key references include the EIA prepared for the proposed drilling operations in the Petronas Zambeze offshore concession (Impacto, 2005) and the EIA for the seismic operations in the M-10 Concession (Impacto, 2007).

6.3.1 *Bathymetry*

Sofala Bay encompasses the southern part of the Sofala Bank (located between latitudes 16°S and 21°S), and represents the largest continental platform of the east African coast. The distance between the coast and the break in the platform is almost 80 nautical miles and the average depth of the continental platform is approximately 20 m. The central and northern regions of the Sofala Bank have a flat bottom characterised by the presence of muddy sediments and active sedimentary movement. High sediment discharge from the Pungue and Buzi Rivers combined with a dominant tidal energy creates intense sedimentation and erosion zones. Seafloor topography near the Port of Beira is very irregular with frequent sand banks in contrast to the more gently sloping areas located further to the north of the Bay (Consultec, 2007).

Bathymetry of the drilling concession of M-10 and Sofala is shown in *Figure 6.1*. The Sofala Concession is mostly in the 15-30 m depth range but extends close to shore in the 5-6.7 m depth ranges, while the M-10 Concession is located in deeper water with roughly half straddling the 15-30 m depth range and the rest dropping steeply over a short distance from 30 to 984 m.

6.3.2 *Salinity Gradients*

The high spatial and temporal variability in salinity that occurs in the Bazaruto Bay to the south is not as marked in Sofala Bay, where salinity gradients are more stable due to the predominant marine influence. Variations in salinity in Sofala Bay are apparent at the river mouths, particularly the Save and Pungue, and are influenced by the significant outflow of water during the rainy season.

At Bazaruto, the water temperature ranges from 23°C in winter to 27°C in summer and the salinity ranges from 35.4 psu in winter to 34.7 psu in summer (Dutton and Zohla, 1990).

6.3.3 *Water Quality and Turbidity in Sofala Bay*

Water quality analysis of temperature, pH, salinity, oxygen levels, turbidity, electrical conductivity, alkalinity and organic (faecal coliform) and bacterial contamination has been sampled in Sofala Bay since 2003 by the Centre of Hygiene, Environment and Medical Exams (CHAIM). The latter six parameters have high values, indicating some degree of organic contamination, predominantly as a result of untreated domestic effluent discharge from the City of Beira. No analyses have been conducted relating to nutrients, metals, or organochlorides since the JICA (1998, cited in Consultec, 2008) study.

An earlier water quality study in 1998 (JICA) in and close to the Beira Estuary included analysis of heavy metals and organochlorides as well as the other standard water quality parameters mentioned above. Turbidity was found to be particularly high during the more intense currents of the outflowing tide and during the spring tide turning point. No clear pattern of turbidity variance was observed during the neap tide turning phases. In all areas sampled turbidity was highest from the bottom decreasing to the surface.

High levels of faecal coliforms were measured in the shallow water areas close to the city, mainly in the rainy season. This was attributed to lower river outflow and less dilution combined with the disposal of untreated effluents from residential areas (namely latrines, wastes and domestic effluents) which reach the water table at this time of year. Nutrient levels showed a reduction in the dry season, even taking into account that the aquatic environment is relatively rich with nutrients in both the dry and raining season.

Metal levels were generally low, and mostly below instrument detection limits as established in the Mozambican standards (Annex V of Decree No. 18/2004), along with the standards of Japan and South Africa. Only near the Port of Beira are there relatively high registers of copper, zinc and hexavalent chromium, mainly in the rainy season and representing suspended particles, probably arising from the geological origin of the Pungue River Basin. Expansion of gold mining in sections of the Pungue River in Mozambique and Zimbabwe may lead to elevated increases in mercury but levels recorded in 1998 showed low contamination, below the South African Standards for Drinking Water.

6.3.4 *Sediment Transport*

Sediments are brought to or lost from the system through:

i) River flows that contain suspended sediment;
ii) Coastal transport induced by waves or tides that contain beach sediment; and
iii) Coastal and open sea currents.

The extensive shallow shelf area combined with a strong tidal influence and significant river outflow from the Buzi and Pungue Rivers of 182 m^3/s and 120 m^3/s respectively results in high levels of natural turbidity in Sofala Bay. This is especially so in the Beira estuary. Historically, sediment from the Zambezi River to the north resulted in sediment import to the bay from longshore drift, but this has now been reduced by the reduction of silt entering the sea as a result of the Cahora Bassa Dam and interception of longshore sediment transport by the Palmeiras spillway at Beira. The annual volume of sand transported along the coast by the marine current is estimated at about 80,000 m^3 but the amount entering Sofala Bay is estimated at

45,000 m^3 due to interception by the spillway. Annual coastal regression in Sofala Bay is in the order of about 10 m (Consultec, 2008).

Sediment transport via the Pungue and Buzi Rivers is highest during flood years, and has contributed to the fine muddy sediments that prevail particularly near the Beira estuary. Elsewhere, away from the river mouths, sediment transport is more regulated by tidal currents, which is the principal mode of sediment movement in Sofala Bay.

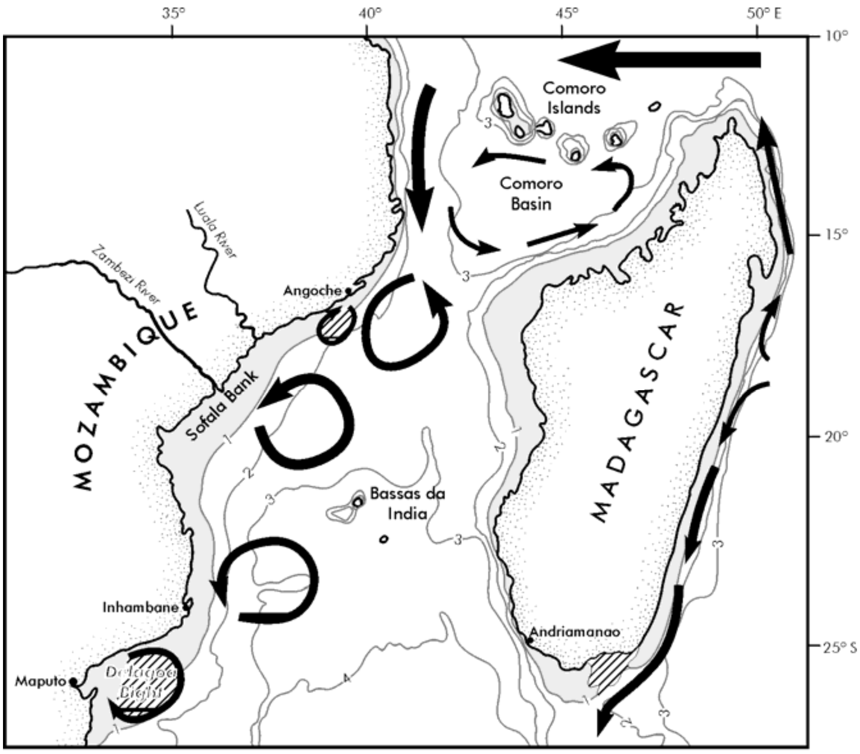
6.3.5 Currents

The circulation of the open ocean adjacent to, and north of, the Bazaruto Archipelago is governed by the Mozambique Channel circulation system which is comprised of a series of intermittent large-scale eddies drifting southward (see *Figure 6.7*). Surface currents associated with this circulation system are known to flow southward throughout the year, with flow speed varying with seasons. Average speed is approximately 0.6 m/s for over 50 percent of the time, with slightly stronger southward flows occurring in the November to April period compared to the May to October period (Saetre, 1985). According to Admiralty (1995), this current is predominantly southwards and is strongest in summer (October to February), attaining speeds of up to 2 m/s during this period and 1.3 m/s at other times of the year. It also indicates that intermittent inshore counter-currents with speeds of approximately 0.8 m/s may occur but these currents are highly variable in speed and direction. Inshore the wave-driven currents are predominantly northwards, consistent with the wave climate in this region.

The shelf circulation in the Sofala Bay area is considered to be a direct result of the Mozambique Channel circulation (Lutjeharms, 2006). The strong southward current along the eastern shelf of Mozambique (Sætre, 1985) is also supported by recent salinity distribution mapping for the region south of the Sofala bank, just north of Bazaruto, where salinity cells drifting southward are evident (*Figure 6.8*).

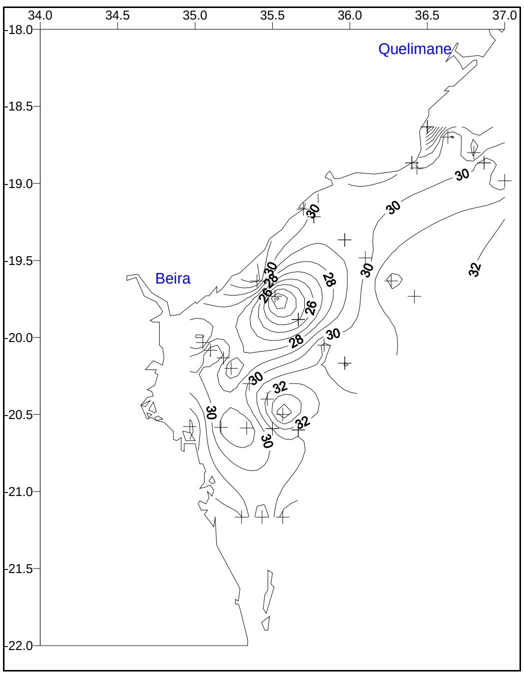
On the continental platform of the Sofala Bank there is a littoral (coastal) current towards the south, from Moma to the Zambezi River mouth, which is narrow and occupies a band extending about 10 nautical miles from the coast to the sea. Further offshore, there is a current from the coast towards the north. The coastal current is caused by the southeasterly wind and is consequently stronger during the winter months, and is responsible for the transport and distribution of fish larvae to the south, along the Sofala Bank, facilitating their migration to the mangrove areas.

Figure 6.7 Major Circulatory Features of the Mozambique Channel and the Continental Shelf of Madagascar. Hatched areas denote upwelling.



Source: After Simpson 1974.

Figure 6.8 Spatial distribution of salinity in the Sofala Bank (psu)



6.3.6 *Tides*

The tides in the project area are semi-diurnal. The tidal amplitude along the coast of Sofala Bay is the highest in the country due to the extensive continental platform. During spring tides the average tidal amplitude near the Port of Beira is 6.4 m (Brinca *et al*., 1984), while in the South of Mozambique the tidal amplitude is 3 m (Hoguane, 1996, Gammelsrød and Hoguane, 1995, cited in Impacto, 2005). The tidal amplitude in Beira is large, varying between 84 and 716 cm during the peak of spring tide and between 109 and 642 cm at the peak of neap tide. The large tidal amplitude is a dominant factor in the area.

Bazaruto Archipelago experiences a different tidal regime than Sofala Bay influenced by the presence of the archipelago itself. Here, the open ocean littoral of the Bazaruto Archipelago experiences low and high tides some 40 minutes ahead of Durban (approximately 1000 km to the south-southwest) while the tides on the inner bay (northeastern Bazaruto) are lagged and more or less coincide with those at Durban (Dutton and Zohla, 1990). The mean spring tidal range is approximately 3 m during normal spring tides, increasing to approximately 4.4 m during equinoctial spring tides (measured at 4.39 m during the equinox of 9 March 1989). The spring tide tidal range produces strong currents in the channels between the islands that transport vast quantities of sand to form extensive flood- and ebb-tide deltas. These strong tidal flows also maintain the deep channels on the landward side of the islands and transport sand across the tidal flats.

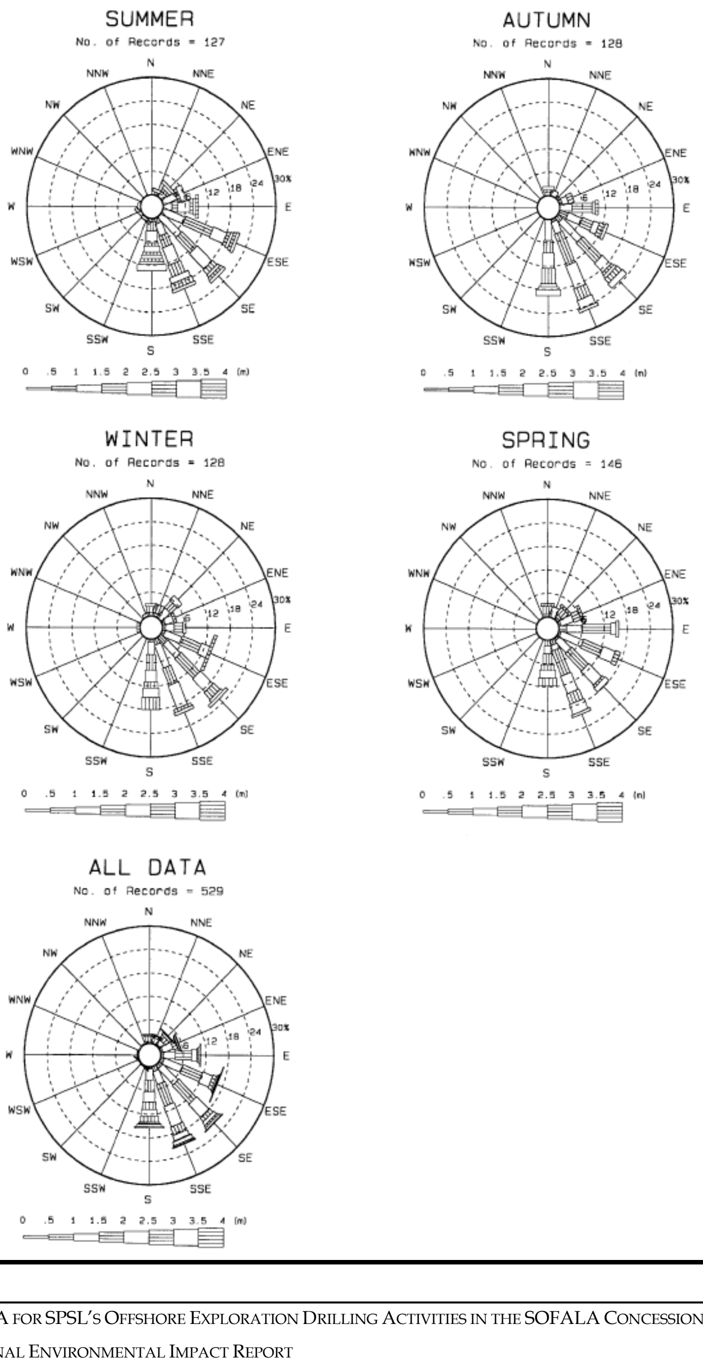
6.3.7 *Waves*

Little information on wave patterms for Sofala Bay exists (Consultec 2008). The offshore wave climate is dominated by waves from a southeasterly sector. These observations are based on Voluntary Observing Ships (VOS) swell observations in a block (21°30’-22°30’S; 35°-36°E) between 1968 and 1998 (*Figure 6.9*). The highest waves are observed to come from the south during summer. The local wind-driven waves are from the southeast sector.

Modelled results from the international system Global Reanalysis of Ocean Waves (GROW) (Oceanweather 2006, in Consultec 2007) for a point close to Beira indicates that in general, the significant waves come from the east-southeast to south middle direction (112.5° to 180°) for 84 percent of the time, with average heights of 0.5 to 2.0 m; and from the northeast to east direction (45° to 90°) for 14 percent of the time, with heights of 0.5 to 2.0 m. Waves greater than 2.5 m in height come from the southeast direction for one percent of the time, and reach up to 6.5 m. The computed wavelengths indicate 4 to 12 seconds interval for 85 percent of the time, and that wavelengths of up to 30 seconds could also occur.

In the Bazaruto area to the south of the drilling concession area the wave action is restricted to the seaward side of the islands and prevents the formation of extensive tidal flats in that area. The small half-heart bays on the seaward side of the islands indicate a dominant littoral drift towards the north, consistent with both the offshore and local wind-driven wave climate. Over the years, the sand transported northwards was deposited at the northern end of the Bazaruto Island to form an extensive spit. The back-barrier area is sheltered from direct wave action and this produces tranquil low-wave conditions (Dutton and Zohla, 1990). The 2003 cyclones significantly modified Bazaruto´s oceanographic morphology, as well as the northern part of Inhassoro and the Cabo de São Sebastião areas.

Figure 6.9 Wave Height and Direction Based on Observations from Voluntary Observing Ships in a Block (21º30'-22º30'S; 35º-36ºE) and for the period 1968 to 1998



6.4 MARINE FAUNA

The Bazaruto Archipelago National Park (BANP) was founded in 1970 in an effort to preserve its high coastal and marine biodiversity. The National Park has been the focus of marine fauna studies since the 1970s. From the early 1990s several research studies on the marine fauna have been undertaken under the umbrella of the Worldwide Fund for Nature (WWF) and the Natural History Museum – Eduardo Mondlane University. More recently, specialist studies on reef fish and dugong were also done in the Bazaruto area to investigate the potential impacts of shallow water drilling by Sasol (ERM and Consultec, 2008). Unfortunately, these studies do not extend northwards into the drilling concession. Information on the concession has been sourced from various studies by Impacto (2000, 2005, and 2007) and specialist inputs drafted for this EIR.

Sofala Bank is the shelf region that extends for over 900 km of coastline from Angoche district in Nampula province (16° 20'S) to Save River mouth (21° 00'S) in the border between Sofala and Inhambane provinces. As with most tropical regions, Sofala Bank supports a great variety of marine and estuarine fauna and is one of the most important fishing grounds of Mozambique.

6.4.1 Plankton

Plankton comprises three components: phytoplankton; zooplankton; and ichthyoplankton.

Phytoplankton and Zooplankton

Studies on primary production of phyto- and zooplankton have been carried out in the south of Sofala Bank, up to the Govuro area by the Institute for Fisheries Research (Instituto de Investigação Pesqueira - IIP) in 2004. Distribution of plankton is also inferred from the distribution of plankton-feeding species such as whale sharks and manta rays as well as species such as tunas and terns, feeding on pelagic schooling fish, such as scads, mackerel and glassnose.

Tunas and terns are commonly seen feeding concurrently in the north and northeastern areas of Bazaruto Archipelago, as well as the deep channel near Bangue Island. These species feed on engraulids and carangidae fish species that are plankton feeders, which suggests the occurrence of some small-scale ephemeral plankton aggregations in this area. The location of whale sharks on the seaward side of the surf zone facing north into the southward oceanic currents suggests the presence of plankton concentrations along the coast. These plankton blooms can be generated by the effect of wave action over shallow sediments that recycle nutrients in the seabed, a process that is assisted by nutrient-rich water draining from small rivers or creeks from wetlands located along the coast between Inhambane and Vilanculos.

Peaks of primary production (chlorophyll-*a*) were recorded in the sea, offshore the Save River and Govuro River estuaries in February 2006 (Emídio André, pers comm, 2006). These peaks are thought to be the result of nutrient-rich freshwater input from the rivers during the rainy season, which are considered to be major sources of nutrients for plankton. The Inhassoro and entire Sofala Bank experiences high nutrient loading due to outflows from the Save, Buzi, Púngue, and Zambezi Rivers, and the sediment inputs causes elevated turbidity, thereby influencing primary production along the coast.

Ichthyoplankton

Ichthyoplankton comprises both fish eggs and larvae, and despite comprising a small component of the overall plankton, it is important for sustaining the commercial fisheries. Little is known about fish larvae distribution in the Project Area, but it is known to be closely linked to variability in salinity. Their apparent ability to tolerate large salinity fluctuations protects them from predation by many non-estuarine predators.

Fluctuations in salinity are less extreme in seagrass meadows, which are widespread in the Bazaruto area to a much greater extent than Sofala (where high turbidity restricts its distribution), and thus provide shelter for fish larvae that are sensitive to such fluctuations. Conversely, there are species that colonize the upper intertidal areas, where salinity increases during low tide, or even following semi-lunar cycles.

Emídio André (pers comm, 2006) observed increases in salinity around the Save and Govuro Rivers during the summer months after heavy rains (January and February 2002). During high tides in winter time, when river flow is low, salt water intrusions into these estuaries result in the accumulation of salts in the sediments. In summer, after rainfall, water with higher salinity outflows into the sea due to flushing out of the accumulated salts in the lower estuarine areas. However, these fluctuations of salinity near the river mouths decrease during winter due to the reduction of river flow into the coastal waters (Emídio André, unpublished, 2006).

At Inhassoro and along the Govuro coast and Sofala Bank, some fish larvae may remain beyond 10-20 m of the coastline to avoid variations in salinity in the wet season. At the Sofala bank, fish larvae appear to use tidal currents to transport themselves to the mangroves as they grow into juvenile fishes (Hoguane, 1997). The extensive mangroves and their creeks provide shelters and nursery grounds for juvenile estuarine fishes, but the fish diversity is low and is dominated by estuarine species in these areas.

The fish diversity in the coast of Govuro towards the Save river is low. However, fish diversity in the Bazaruto Archipelago and Inhassoro coast is very high (attaining at Bazaruto Archipelago at least 113 species in the seagrass meadows. Studies of catches of the artisanal fisheries at the Inhassoro Coast reveal similar species diversity and dominance due to extensive seagrass meadows (Tivane 2008).

6.4.2 *Large Invertebrates*

Crustaceans are a diverse group of fauna which includes shrimp, lobsters and crabs. They are widespread and found in nearly all marine habitats in the project area. Rock lobsters are found in the intertidal rocky shore (*Palinurus spp)* and in deep recesses of the rocky reefs (*Palinurus delagoae)* while crabs are found in a diversity of habitats ranging from sandy flats and shores, rocky shores, mangroves, and salt marshes, seagrass, coral reefs, and deeper water. Mangrove mud crab (*Scylla serrata*) are common in the estuaries and the mangrove creeks at Sofala Bank (from Govuro Bay and northward) while the blue crab species (*Portunus sanguinolentus*) is abundant in the turbid but saline shallow waters (depth<20 m) of the Sofala Bank.

In the Sofala Bank, prawns are generally abundant in shallow water (along the coast, associated with the mangroves), but also occur in deep water as well as surface water. The most common species belong to the *Penaeidae* family, and include the white prawn (*Penaeus indicus*) and brown or ginger prawn (*Metapenaeus monoceros*). Other species such as the Tiger prawn (*Penaeus monodon*), the flower or banana prawn (*Penaeus japonicus)* and the zebra prawn (*Penaeus semisulcatus*) also occur (Impacto, 2007 and Entrix, 1998). The Sofala Bank is one of the most important prawn fishing grounds of Mozambique where 90 percent of the prawns caught consist of two species: *Penaeus indicus* and *Metapenaeus monoceros* (Brinca and Sousa, 1984). These species are associated with estuarine habitats such as the Save River mouth as these are important nursery areas for post-larvae and juveniles. Sub-adults and adults are distributed on the continental shelf on sandy mud and/or muddy sand sediments (FAO, 1979) usually in the 20 to 50 m depth zone (ie inner shelf). Shrimp are fished either in this zone or during their migrations out of estuaries. Commercial catches of *P. indicus* and *M. monoceros* is related to river discharge and rainfall (le Reste 1978, Garcia 1985, da Silva 1986, Gammelsrod 1992, Dall *et al*., 1990), further emphasizing the importance of the estuarine function in the fishery.

Several species of cephalopods occur in the project area and adjacent habitats, although there is no complete record of species in the project area. They have a vertical underwater distribution and consist of squids, cuttlefish and octopus species. Squid species are common in the deep open sea. The only shallow water squid species (Indian squid) that may occur east of the 20 m depth contour (about 15 to 25 km from the coast between the Save River and

Inhassoro), where the depth range may be appropriate. Octopus and most cuttlefish species are common in the shallow coastal waters.

In Bazaruto Bay, deep channels near-shore allows some squid species to be caught by the beach seine fishery. Most individuals caught are juveniles (immature) specimens of the diamond-back squid and Indian squid. Apparently, squids are attracted to the seagrass areas, to forage and for shelter. The cuttlefish (*Sepia pharaonis*) is common in shallow waters and dominates the beach seine fishery in the coast of Vilanculos and Inhassoro Districts.

Apart from the commercially important invertebrates, other benthic invertebrate fauna that dwells in and on the sea floor in the Sofala Bank area are poorly known and there is no information on the distribution and abundance of the mocs common benthic types such as polychaete worms, molluscs and small crustaceans, such as copepods and ostracods. Offshore benthic fauna on sandy-muddy substrates are considered less productive and to have lower species diversity that shallower reef habitats. Benthic species in sandy-muddy habitats are expected to be fairly homogeneous and widespread across the Sofala Bank.

6.4.3 Fish

The 2,000 species of fish, which occur around the BazarutoArchipelago, situated 50 km to the south of the concession area, represents more than 80 percent of all marine fish families of the Indo-pacific region (CSIR, 2000). The incidence of endemism [(1)] is either absent or very low. Sailfish, three species of marlin, sharks and migratory tuna are common in the deeper waters off the continental shelf, and are targeted by recreational fishermen.

Within the floodplains of the Govuro and Save Rivers, Red-breasted Tilapia, Mozambique Tilapia and Black Tilapia are known to occur. Mozambique Tilapia and the Black Tilapia are particularly abundant in the barrier lakes and form an important part of the subsistence fisheries in the area (Mark Wood Consultants *et al.*, 2002). Species of fish in the Sofala Bank region are divided into three categories (Impacto, 2007, Impacto, 2005 and Entrix, 1998):

- Pelagic species: mainly anchovies (*Stolephorus* sp), sardines (several species), Crevalle Jack (*Caranx hippos*), several species of herring, mackerel (*Scomberomorous* sp), and barracudas (four species).

- Demersal species: croakers (*Johnius belangerii, J. dussumieri, Otolithes rubber),* grunts *(Pomadasys hasta, P. maculates),* goatfish *(Upeneus vittatus),* lizardfish *(Saurida undosquamis)* and hartails *(Trichurus lepturus).*

(1) Species which are native to a particular geographic area or region.

- Coastal/estuarine species: mainly glassies (*Ambassis safgha),* pufferfish *(Arothron immaculatus),* mullet *(Valmugil* sp., *Mugil* sp.*),* thornfish *(Therapon jarbua),* blackspot snapper *(Lutjannus fulviflamma),* Indian anchovy *(Anchoviella indica),* blueline herring *(Harengula ovalis),* spotted halfbeak *(Hemiranphus far),* silverside *(Pranesus pinguis),* rabbitfish *(Siganus rivulatus),* among others.

Most information on fish species is obtained from research on the artisanal and industrial fishery (Masquine et al, 2003, and Torres and Alvaro, 2008), and trawl net fish cruises carried out in 1981 (Timochin 1984). Fish species caught in the semi-industrial fishery in southern Mozambique include 53 species, of which five account for 61.5% of the composition. These are Spanish mackerel (*Scomberomrus commerson*), *Outros, Pristipomoides filamentosus,* Seabream (*Cheimerius nufar* and *Chrysoblephus puniceus)*. Trawl net data from Sofala Province indicate 27 species are caught in this fishery.

Beach seine catches in Machanga showed a weight ratio of prawn to fish of 1:8 (Pereira *et al.*, 2005). Since 2004, 60 different species in 38 families were listed, comprising mostly small pelagic fish, especially anchovies and sardines (ERM and Consultec, 2008).

Pelagic fish occurring over the shelf up to 200 m depth include *Thunus albacares*, *T. obesus, T. alalunga, Katsuvwomus pelamis, and Coryphaena hippurus* and *Elagathis bipinnulata* (Simoes 1984). Demersal species include 97 species while only 16 pelagic species were recorded, including shallow water coastal species, and migrant deeper water pelagic species. Despite high fish diversity, only eight species are common.

Species important in the recreational fishery include marlin, sailfish, wahoo, dorado, giant kingfish and king mackerel. Marlin is caught close to reefs. Black marlin is the most common, but blue and striped marlin also occur. The giant black marlin is a migratory species occurring in the summer months, while sailfish occurs year round but is more common in winter (May-October). King mackerel is the most abundant and commonly caught recreational fish.

Pelagic sharks include the Zambezi, dusky, blacktip, hammerhead and tiger sharks. Five demersal sharks have been caught offshore the Sofala Bank, (*Squatina qfricana, Carcharinus sealei, Rhinobatus annulatus, Stegostoma fascitum* and *Heterodontus ramalheira*), all of which are Data Deficient or Not Threatened and most occur in the 100-200 m depth zone. Demersal elasmobranchs (sharks and rays) caught in trawl nets in the southern part of Sofala Bank in water over 55 m deep are *Scoliodon walbeehmi, Mustelus canis, Rachycentron canadus* and *Rhynobatus dieddensis,* all of which are listed as Not Threatened or Data Deficient (www.iucnredlist.org).

The whale shark (*Rhinocodon typus)* is closely related to bottom dwelling sharks Orectolobiformes, with a broad distribution in tropical and warm temperate seas, usually between lattidutes 30 degrees north and 35 degrees south. It usually inhabits deep and shallow coastal waters, lagoons and reefs. Individual whale sharks have been identified in the open sea near the coast between Pomene and Bazaruto Island but there is no information on their occurrence in the Project Area in Sofala Bay.

The proposed concession overlaps an important fishing ground, the Sofala Bank, and information about the fisheries in this area is provided in *Section 7.3*.

6.4.4 Avifauna

More than 180 bird species have been recorded in the Bazaruto Archipelago (Reina, 1998). Guissamulo (2005) identified a total of 31 seabirds at the Archipelago, of which 16 were waders. Waders are dominated by terns which mostly roost on the northwestern beaches of Bazaruto Island and feed north and offshore of the islands. Greater flamingos occur near the northern Bazaruto Island and on the extensive beaches in other parts of Bazaruto Bay.

Bazaruto Archipelago is a registered Ramsar Site ie a Wetland of International Importance, highlighted as such for its bird counts undertaken in 1996 and 1997. The most common species of seabirds that seek shelter at these beaches are: Grey Plover (*Pluvialis squatarola*), Lesser Crested Tern (*Sterna bengalensi),* Common Tern (*Sterna hirundo),* Little Tern (*Sterna albifrons)* and Whimbrel (*Numerius phaeophus). A*nother species of importance in Bazaruto is the Bartailed Godwit (*Limosa lapponica)*.

Although a bird count has not been carried out for all beaches adjacent to the Project Area, additional areas of importance for birds are the São Sebastião and Ponta Minga beach areas, as well as the Bartolomeu Dias area, all situated south of the Save River. Along with riverine areas, the small and isolated Bangue Island is also an important roosting site for birds, as well as the southeastern section of Magaruque Island in the Bazaruto Archipelago National Park.

In addition, Mozambique has several wetlands along the coastline, which are visited by migratory species. One of the most important wetlands is in Marromeu/Zambezi River Delta to the north of Beira, which has been declared a RAMSAR site for its unique array of wetland fauna. It is primarily important for its population of wattled crane (*Gnus carcuculatus*), an IUCN listed species registered as Vulnerable and with an estimated 120 pairs in the Zambezi delta. Other important populations of known wetland birds in the area include Reed Cormorants; Open-billed Stork; Caspian Plover and Whiskered Tern. The Zambezi delta is also an important fish spawning ground with 80 fish species. Mammals associated with the delta region include kobus and red lechwe, hippopotamus, crocodiles (all CITES Appendix II), and sitatunga and tsessebe (CITES Appendix III). The mangroves along the entire coast are important feeding grounds for seabirds.

The broader Project Area has 14 IUCN Red Data bird species of which 12 species are listed as Rare and two as Vulnerable. Seven of the 14 species are predominantly wetland species, and were recorded in the wetland areas associated with the Pungue, Save and the Govuro flood plains systems, and the lakes to the east of the Govuro River, and in various water pans found within the area. None are restricted to the seashore near the project area, but five are pelagic birds that may enter the project area. These include the Wandering Albatross (*Diomedea exulans)* and White-chinned Petrel (*Procellaria aequinoctialis*), both listed as Near Threatened, and the Atlantic Yellow-nosed Albatross (*Thalassarche chlororhynchos*) and Indian Yellow-nosed Albatross (*T. carteri*), both listed as Endangered. These species are at particular risk from the long-line fishing industry.

6.4.5 *Cetaceans (Whales and Dolphins)*

Cetaceans in the Mozambique marine environment and which occur in the broader project area comprise five species of dolphin, five species of toothed whales and two species of baleen whales. All are listed as protected species in Mozambique (Decree No. 12/2002). Cetaceans occuring in the project area and their IUCN status is provided in *Table 6.2***.**

Table 6.2 ***Cetaceans Identified in the Area (Guissamulo, 2005)***

Common name	Scientific name	IUCN status
Common dolphin	*Delphinus delphis*	Least Concern
Hump-back dolphin	*Sousa plumbea*	Near Threatened
Bottlenose dolphin	*Tursiops truncatus*	Least Concern
Spinner dolphin	*Stenella longirostris*	Data Deficient
Spotted dolphin	*Stenella attenuate*	Least Concern
Pilot whale	*Globicephala melas*	Data Deficient
False killer whale	*Pseudorca crassidens*	Data Deficient
Beaked whale	*Unknown*	
Sperm whale	*Physeter macrocephalus*	Vulnerable
Dwarf sperm whale	*Kogia breviceps*	Data Deficient
Minke whale	*Balanoptera acutorrostra*	Least Concern
Humpback whale	*Magtera novaeangliae*	Least Concern

Dolphins

All five dolphins listed in *Table 6.2* have been recorded in Bazaruto National Park (BANP) according to the BANP Management Plan (Ministério do Turismo, 2002). A study of dolphin distribution and abundance carried out in the Bazaruto Bay between 2002 and 2003 (Cumbi, 2004) showed that bottlenose dolphins are very common throughout the bay area (the entire area between Inhassoro and Benguerua) and throughout the year. Humpback dolphins also occurred but in much smaller numbers, mostly over shallow sandy substrate. Their distribution is generally restricted to shallow coastal areas of the mainland and passes to open water near the islands.

Common (*Delphinus delphis*), spinner (*Stenella longirostris*) and spotted dolphins (*Stenella attenuate*) occur in the offshore areas, but population estimates and ecology in the area are not known. These species are highly mobile with very large ranges as they follow their pelagic food sources. A number of strandings of spinner dolphins were recorded in 1995 at Bazaruto Island. Spinner dolpin and humpback whale have been observed in the Sofala Bank area, and others likely to occur include Indian humpback dolphin (*Sousa plumbea*) and the bottlenose dolphin (*Turciops aduncus*).

Toothed Whales

Pilot (*Globicephala melas*) and false killer whales (*Pseudorca crassidens*) are found in the deep offshore waters of Mozambique, which are also important for a number of beaked, sperm (*Physester macrocephalus*) and dwarf sperm whales (*Kogia breviceps*) that feed on large demersal squid.

Baleen whales

Minke and humpback whales are common in the area and have been reported in the Bazaruto Bay and offshore of Bazaruto Island during the reproductive season (Guissamulo and Cockcroft, 1997). Mothers and calves have been observed near the northern area of Bazaruto Point and inside the Bazaruto Bay, and are common in the area between May and November before their southward migration to the Antarctic Ocean.

6.4.6 Dugongs

Dugongs (*Dugong dugong*) are long-lived, aquatic mammals, with a lifespan of about 70 years. They give birth from the age of 10 years to single calves, after a gestation of 12 months. Calves suckle for 18 months or more and the calving interval is 3 to 5 years (Guissamulo and Cockcroft, 1997). Dugongs occur in shallow tropical and subtropical coastal and island waters of the Indo-Pacific, where their occurrence is strongly associated with seagrass distribution. They are threatened worldwide due to loss and degradation of seagrass pastures, fishing pressure, indigenous use and hunting, and coastal pollution and are listed globally by IUCN as Vulnerable to extinction (WWF and UNEP, 2004). Dugongs are a protected species in Mozambique (Decree No. 12/2002).

The largest remaining population of dugongs in the Western Indian Ocean Region occurs within the Bazaruto Archipelago (approximately 70 km from the southern limit of the Sofala Concession). An aerial census involving 27 flights between April 2006 and December 2007 covering the area between the

Save River in the north and Cabo Sao Sebastio in the south estimated the population at around 250 individuals (Cockcroft *et al.*, 2008). Two core areas were identified: a northern area between the Save River and 21°24′ S, and a southern core, located north and south of South Carolina Island. In the northern core, seagrass distribution coincided with areas of higher dugong abundance, in waters generally less than 8 m deep. However, no seagrass was evident at the southern core suggesting their presence there for reasons other than feeding. Dugongs were generally sighted within 15 km from shore, mostly as individuals (56 percent), or as pairs (28 percent) but sometimes in small herds of two or three in which a calf may occur. Dugongs sometimes formed large aggregations, generally gathering when tide conditions preclude access to feeding grounds, which were observed inside Bazaruto Bay as well as offshore 10 km east of the Save River mouth, and were observed in Concessions 16 and 19.

Population viability analysis suggests the Bazaruto population of dugong faces extirpation unless there is significant management intervention to protect this species. Bazaruto has been identified as the southernmost distribution of this species in the Indian Ocean on the East Coast of Africa but dugong densities are lower than in the Arabian Gulf or Australia.

The dugong's primary habitats are found in the sheltered bays between the islands and the seagrass beds (CSIR, 2000). Surveys eastward and offshore of Bazaruto Islands showed that dugongs move extensively to the offshore shallow areas during low tide to escape the risk of stranding. As a result, the *Dugong Conservation Strategy for the Western Indian Ocean* (WWF and UNEP, 2004) proposes an area for dugong protection northwards of BANP.

There is no evidence of dugongs in the Sofala Bank region, probably largely related to the absence of seagrass, although it is possible that the area may serve as a migration corridor between northern and southern Mozambique, and thus it is possible that solitary individuals may occur offshore towards the 20 m isobath.

6.4.7 *Sea Turtles*

According to Hughes (1971), cited in ERM/ Consultec (2006), five species of sea turtles are likely to occur in the area, namely: green (*Chelonia mydas*), loggerhead (*Caretta caretta*), olive-ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*) and hawksbill turtles (*Eretmochelys imbricata*). Green turtle and Loggerhead turtles are listed as Endangered by the IUCN, while leatherback and hawksbill are listed as Critically Endangered (www.iucnredlist.org).

Turtles are regarded as common over the entire area between Save and Southern Benguerua Island, and rare or uncommon in the extensive shallow waters of southern Bazaruto Bay, with most located between Bazaruto Island up to Bartolomeu Dias. The majority are green turtles with a few leatherbacks (Provancha and Stolen, 2008). Green and loggerhead turtles are often caught in the inshore beach seine fishery, which indicates the presence of these species in the inshore waters of Inhassoro and Bazaruto Bay (Chacate, 2005 in Impacto, 2005). They are also caught in trawl nets off the coast of Inhassoro. Most catches of adults occur between October and December and are lower at other times of the year. Catch intensity increases towards the northern coast of Inhassoro and Govuro (0.6 turtles/seine net). Some turtles are killed on illegal offshore long-lines in nearshore waters east of the Bazaruto Archipelago.

The loggerhead and leatherback turtles reportedly nest to the south of the project area while green turtles, which nest in the north of Mozambique, travel through the waters of the project area. The leatherback turtle is thought to nest in the São Sebastião area. Surveys in Bazaruto Bay (Mackie, 2001; Mackie *et al* 1999) estimated 321 turtles.

Some sections of the coast in the Sofala Province, mainly in Praia Nova, Nova Sofala and Savane, have sandy beaches which can serve as nesting sites for the loggerhead turtle.

The nesting season of these turtles occurs between October and February and hatched turtles are found between January and April. These periods are critical for nesting, however, resident turtle species, such as the green turtle, are thought to occur throughout the year.

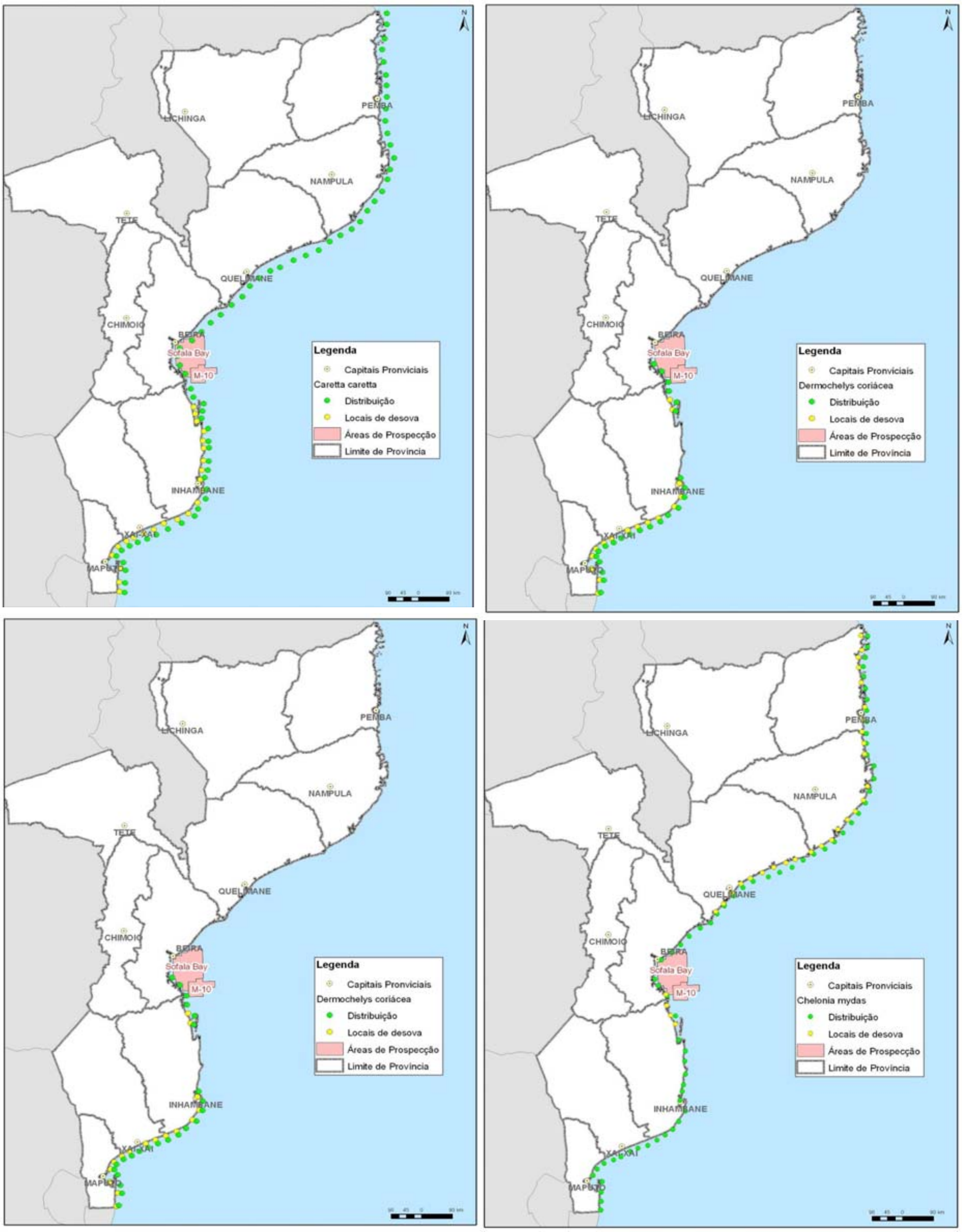
An estimated 1932 to 5436 turtles are caught yearly in trawl nets used to catch prawns on the Sofala Bank (Gove *et al.*, 2001). They are mostly captured to the south of Sofala Bank at Chami Chami, offshore of the coast of Govuro and Machanga, and south of Beria and at Savane (north of Beira).

Figure 6.10 shows the distribution and nesting sites of the most common turtle species (Adapted from Louro *et al*., 2006, cited in Impacto, 2007). Olive-ridley turtles tend to occur along the northern Mozambique coastline to the north of Sofala Bay, although it is possible that indivuals may stray into the project area.

6.4.8 Seals

Two seal species namely the crab-eater seal *Lobodon carcinophagus* and sub-antarctic fur seal *Artocephalus tropicalis* have been found in the area but Mozambican coastal waters are considered outside their normal distribution range and these records suggest vagrant individuals (Guissamulo and Cockroft, 1996).

Figure 6.10 Turtle Distribution in the Coastal Region of Mozambique. Top left: Loggerhead turtle (Caretta caretta); Top right: Leatherback turtle (Dermochelys coriacea); Bottom left: Green turtle (Chelonia mydas); Bottom right: Hawksbill turtle (Eretmochelys imbricata)



6.5 SENSITIVE MARINE ENVIRONMENTS

6.5.1 *Overview*

The Mozambican coastline can be divided into three main regions. The central region, in which the Project Area occurs, stretches between Angoche and Bazaruto Island and can be classified as swamp coast (Entrix, 1998). This coast is made up of simple linear to arched beaches, alternating with swamps and estuaries. Mangrove forests are well-developed in this area and form an almost continuous fringe along the coast (Entrix, 1998; Impacto, 2005, 2007) (see *Section 6.5.5* for more information on mangroves). Four major rivers (Pungue, Buzi, Gorongosa and Save) and several smaller streams enter the sea within the study area, and each river ends in an estuary with mangrove swamps (Entrix, 1998).

This section provides a brief description of natural environments or habitat types / ecological communities that occur in the greater Project Area and which are regarded as sensitive due to their ecological importance or vulnerability to disturbance. Most of these sensitive features (eg coral reefs, seagrass beds) are located south of the concession and outside the area of direct influence of drilling activities, largely due to the high offshore turbidity and sedimentation in Sofala Bay resulting from the outflow from several rivers along the coast. Mangroves, however, are in high abundance along the Sofala Bay coastline and are discussed below.

6.5.2 *Coral Reefs*

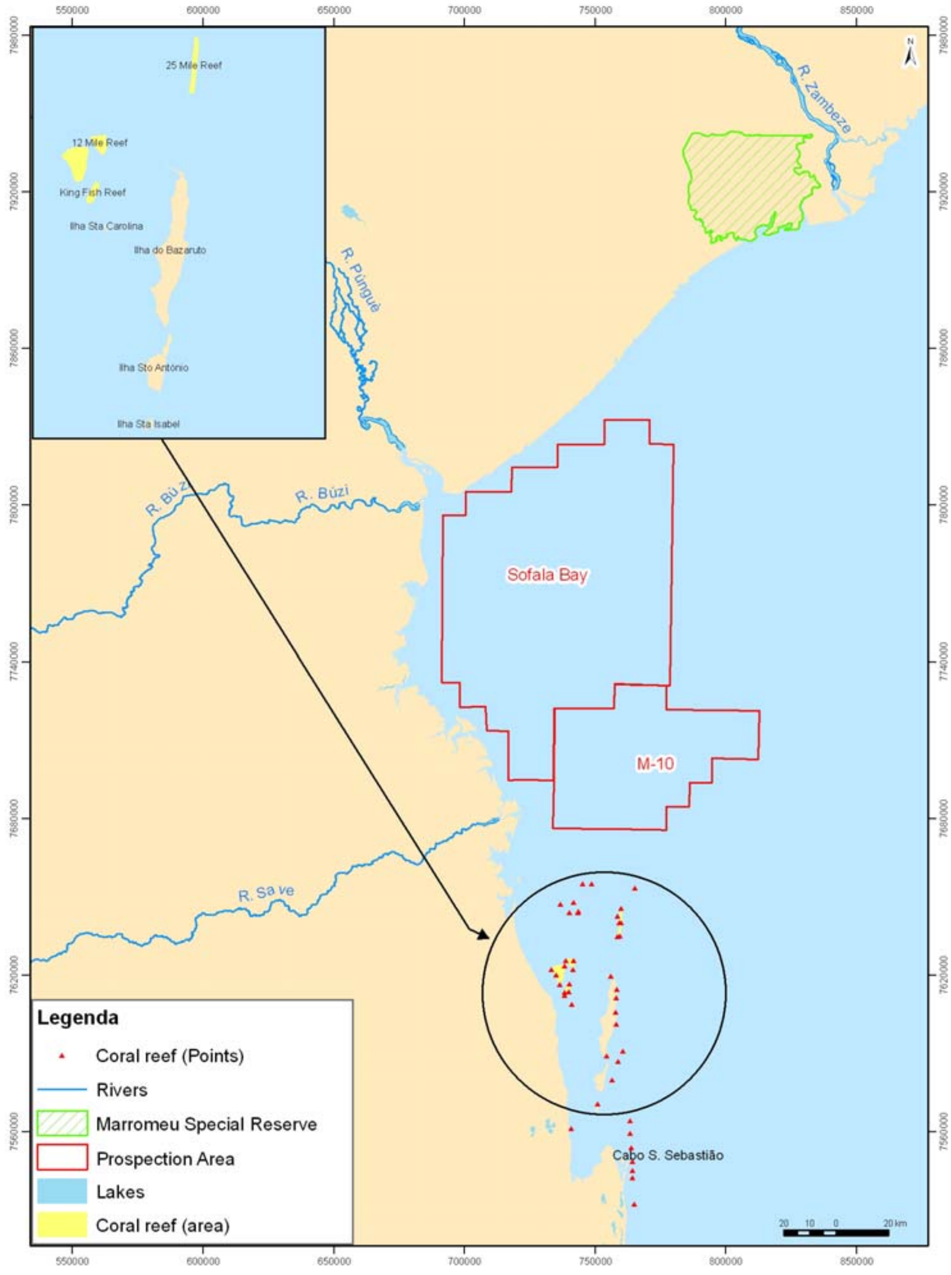
Corals occur in areas of clear subtropical water carried southward by the warm Mozambique Current, and where there is an absence of silt-carrying rivers along the coastline combined with suitable submerged substrata in the form of sandstone beach rocks (ERM and Consultec, 2006). All the coral reefs in the broader Project Area occur to the south around Bazaruto Archipelago (*Figure 6.11*).

The closest and most important reefs to the Sofala Concession are two submerged offshore reefs: the Twelve Mile Reef, located 12 miles north-northeast of Bazaruto's northern point, and the Twenty-Four Mile Reef. Twelve Mile reef is a large reef 18 to 25 m in depth and consists of flat rock, dropping in fissures, gulleys and low walls to the surrounding sediment. It displays a mixed coral community with corals, sponges, and sea fans (Schleyer and Maggs, 2008). Significant damage to the reefs was observed from Cyclone Favio. A number of other reefs fringe the east inshore coast of Bazaruto Island and there are other rocky reef areas located along the longitude 35°30' E, east of the Islands of Benguerua, Magaruque and Bangue.

Lighthouse Reef and the Two Mile Reef (south of Bazaruto Island) have been monitored under the CORDIO project since 1999 (Coral Reef Degradation in the Indian Ocean), to assess coral condition and the impact of bleaching. These sites have high species diversity comprising 18 genera of hard corals, five genera of soft corals (*Dendronepththea, Lobophytum, Nephthea, Sarcophyton* and *Xenia*) and one species of black coral (*Antiphates*).

No coral reefs are reported in Sofala Bay close to the drilling concession area.

Figure 6.11 Distribution of Coral Reefs in the Wider Project Area



6.5.3 *Seagrass*

Seagrass meadows are highly productive, shallow water systems that play an important role as nursery grounds and refuge for fish, and are a major food source and shelter for other animals, such as dugongs and green turtles, as well as supporting a rich marine fauna of echinoderms, crustaceans, molluscs and coelenterates. Seagrass habitats support commercially valuable shrimp and prawn populations. They occur in areas with bottom sediments of sand to silt and typically have low sediment deposition rates and weak currents. They play a major ecological role in stabilising substrate and once disturbed, are not easily recolonised. Besides turbidity, and exposure to air and heat, light is a key limiting factor constraining their extent and they tend to be limited to depths less than 8 m.

The distribution and composition of seagrass meadows within Bazaruto Bay was studied between Inhassoro and Cabo São Sebastião in 2006/2007 (Cockcroft *et al.,* 2008). Here, an estimated 88 km^2 is covered by seagrass in the shallow intertidal and subtidal waters above the 5 m isobath, where nine species have been identified. Certain seagrass species occurred north of Bazaruto to Inhassoro Bay, just south of the Save River. A transect from shore to sea inside the Bay showed seagrass peaked at 500 to 2,500m from shore and was dominated by *Thalassodendron ciliatum* while *Cymodocea rotudanta* only occurred at 3,500 and 4,000 m from shore.

No seagrass communities are known to occur in Sofala Bay along the coast west of the drilling concession area.

6.5.4 *Estuaries*

There are four main estuaries in the study area, namely the Pungue (located at Beira), Buzi, Gorongosa and Save River estuaries. Mangrove forests form an integral part of these estuaries. These rivers are vitally important for feeding freshwater into the mangrove forests that occur in the estuaries.

6.5.5 *Mangroves*

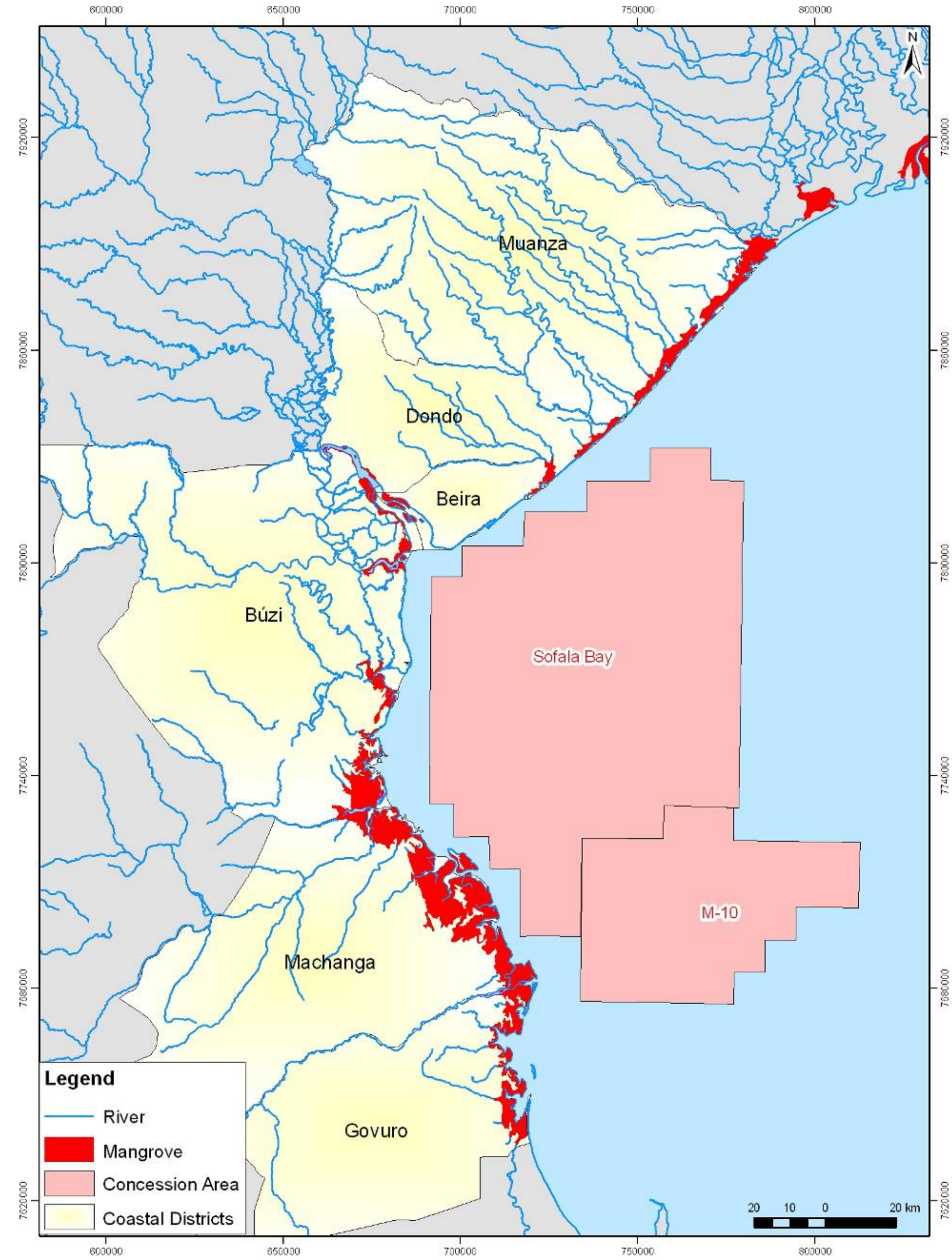
Mangroves are highly productive ecosystems and are especially important for the diversity of life they support. Mangrove forests occurring along tropical and sub-tropical coasts consist of trees that are physiologically adapted to regular inundations of seawater. Mangroves are characterised by high levels of biological production and structural diversity as they grow on the edge of sea and land and benefit from the inflow of nutritious (sediment-laden) river waters. Mangroves mostly occur in intertidal shallow bays and estuaries where deposition of hydromorphic clays has taken place leaving tidal mud flats and extensive areas with intertidal creeks, which they colonise. Mangrove forests provide litter (such as fallen leaves) that is broken down by bacteria, fungi and herbivores. The resulting detritus supports food webs including large populations of invertebrates and fish. The calm waters in the forests are ideal nursery grounds for young fish and shrimps, while the aerial roots, lower trunks and mud surface usually support a varied fauna of oysters, snails, barnacles, crabs and other invertebrates. Mangroves also trap and stabilise sediments thereby consolidating shorelines and protecting them from flood damage and wave erosion.

Mangrove forests in the Project Area are well-developed and form an almost continuous fringe along the coast extending from just below the high water mark up to a few kilometres inland (see *Figure 6.12*). They surround almost every estuary or river mouth in the Project Area. The Govuro and Save River areas possess the largest extent of mangrove forests, where some damage from cyclone events and exploitation for wood and development of a salt works is evident.

Mangrove swamps also occur extensively in the lower Zambezi delta (a Ramsar site), extending up the main channels for over 15 km. South of the Zambezi to Beira, the alluvium of at least 18 rivers produced a continuously deltaic coast, and the mangroves occur along the coast are exposed to the open sea (Impacto, 2005).

A vegetation survey conducted for the Temane Gas Field EIA (Mark Wood Consultants *et al*., 2002) in an area south of the Concession indicated that at least eight mangrove tree species occur within the mangrove forests. These included: *Avicennia marina, Bruguiera gymnorhiza, Rhizophora mucronata, Lumnitzera racemosa, Ceriops tagal, Sonneratia alba, Heritiera littoralis* and *Xylocarpus granatum.* The only common herbaceous species occurring in mangrove forests is the halophytic fern *Acrostichum aureum.*

Figure 6.12 Distribution of Mangrove Forests along Study Area Coastline (mangroves denoted in red)

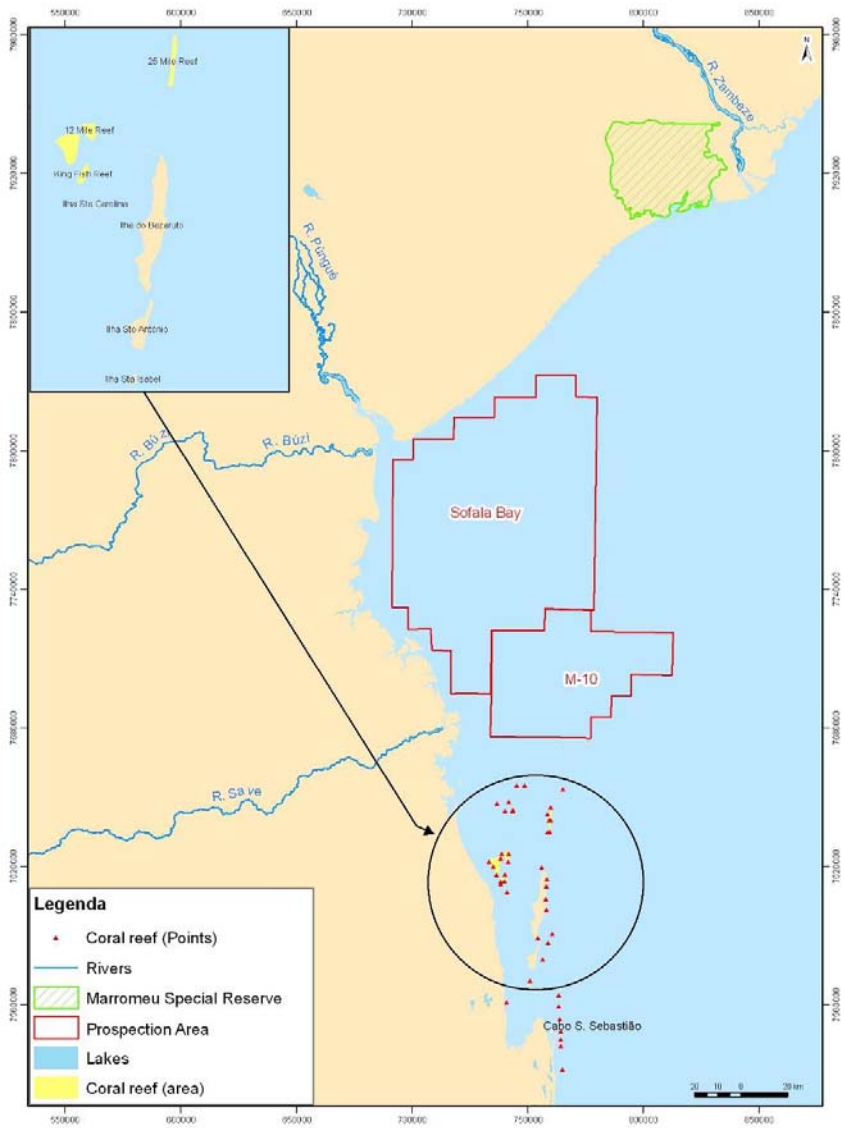


6.6 *PROTECTED AREAS AND SPECIES*

6.6.1 *Protected Areas*

No protected areas occur within the immediate Project Area. The closest protected area, the Bazaruto Archipelago National Park, is located approximately 60 km from the southern limit of the Sofala Concession (*Figure 6.13*). To the north, the Marromeu National Park, a Ramsar site, is located in the southern part of the Zambezi Delta. The distribution of mangroves is not shown (see previous figure).

Figure 6.13 Protected Areas and Sensitive Ecoystems in the Project Area



Bazaruto Archipelago National Park

The Bazaruto Archipelago became a Marine Protected Area (MPA) in 1971 and was proclaimed the Bazaruto Archipelago National Park (BANP) in 2001 with the aim of protecting the marine fauna, specifically dugongs and sea turtles. The original MPA area covered three islands, namely the Bangue, Magaruque and Benguerra Islands in the district of Vilankulo. Under Decree No. 39/2001, the BANP expanded the boundary to incorporate the Bazaruto and the Santa Carolina Islands.

The responsible authority for managing the park lies with the Ministry of Tourism under the National Directorate for Conservation Areas (DNAC) as tourism is seen as a key means of financing protected areas. Although managed by DNAC, other partners are directly involved, including the Natinal Directorate for Environmental Management including the Department of Coastal Management and the Centre for Sustainable Development for Coastal Zones with the Ministry for Co-ordination of Environmental Affairs (MICOA), the National Fisheries Research Institute (IIP) and the Institute for Development of Small Scale Fisheries (IDPPE).

The Park's Management Plan for 2008-2012, developed with the support of the World Wide Fund for Nature (WWF) and approved by the Ministry of Tourism, outlines requirements for protection, restoration and management of the park. A first phase of investment was recently completed involving upgrade of facilities and infrastructure in the park, particularly that which was destroyed by Cyclone Favio. A further phase of investment is planned.

Marromeu Game Reserve and Ramsar Site

Marromeu Game Reserve (sometimes referred to as a National Park) covers 688,000 hectares and was registered as a Ramsar site in 2004. It is also indicated as a Marine Protected Area. The Ramsar site comprises the Marromeu Buffalo Reserve (with a population of about 10,000 Cape buffalo), four hunting concession areas, and buffer areas to the southwestern side and the northeastern side. It includes a variety of habitats ranging from Zambezi coastal flooded savanna, coastal dunes, grassland, freshwater swamps, miombo forest with dambos, mangroves and seagrass beds. The Zambezi Delta area supports three to four percent of the global population of wattled crane (*Grus carcunculatus*) and may provide a critical refuge for this species during drought when more than 30 percent of the global population may congregate there temporarily. It is also internationally important for White- and Pink-backed Pelicans (*Pelecanus onocrotalus* and *P. rufescens*) and for the African Open-billed Stork, (*Anastomus lamelligerus)*, amongst others.

Apart from threats from reduced natural flooding of the Zambezi River due to dam building, and construction of roads, railways and flood protection dykes, the area also faces threats from the oil and gas industry through prospecting and drilling for onshore gas. One drill site was established in Coutada 12, a hunting concession in the complex, but later dismantled in 2008. Mozambique has been advised to closely observe the requirements of the Ramsar Convention with regard to activities that may potentially affect wetlands (Pritchard *et al.*, 2009).

6.6.2 *Protected Species*

The regulations for Forest and Natural Reserves (Decree No. 12/2002) include a list of protected animal species which occur in the study zone, namely the dugong, sea turtle species and some marine and coastal bird species.

The regulations for Recreational and Sports Fishing (Decree No. 51/99) include an additional list of protected marine species including the sea mammals (dugongs, whales and dolphins), sea turtles, and some species of fish, bivalves and gastropods.

Despite the protected status of a number of marine fauna in the project area, there is little enforcement of fishing restrictions on these species, and great numbers continue to be caught in non-selective fishing gear (eg turtles) and many pelagic birds (eg albatrosses and petrels) are caught in the long-line fishery.

A Dugong Conservation Strategy for the Western Indian Ocean (WWF and UNEP, 2004) proposes a new area for dugong protection northwards of the BANP. Signing of a Memorandum of Understanding for the Protection of Dugongs and their Habitats in the Indian Ocean and South East Asia conference of parties scheduled for October 2010 is expected to lead to the adoption of a regional management plan for dugong conservation by the Mozambican Government.

7 SOCIO-ECONOMIC BASELINE

7.1 INTRODUCTION

The proposed project lies offshore the Provinces of Sofala and Inhambane in the south-central region of Mozambique. The Save River forms the border between these two provinces and the Zambezi River forms the border of Sofala Province in the north (*Figure 6.13* above). The capital of Sofala Province is Beira. The demographic profile of Sofala and Inhambane Provinces is described in *Sections 7.2.1* and *7.2.2* below.

As the project's drilling activities will occur offshore, with support vessels and staff operating out of Beira, it is expected that the social interactions of the project will relate primarily to the fishing activities around the Sofala Bank, and from the use of the Beira Port. This socio-economic baseline therefore focuses on the areas and activities that are most likely to be at risk of interaction with the drilling project in the broader Project Area ie the coastal region of Sofala Province, the northern district of Inhambane Province (Govuro) and City of Beira. It provides a general description of the coastal districts and their respective coastal population settlements (within a radius of 10 km from the coastline). The coastal districts lying immediately offshore the drilling concessions and within the broader project area of the Sofala and M-10 Concessions are Govuro District (Province of Inhambane), and the Districts of Machanga, Buzi, Dondo and the City of Beira (in Sofala Province) (*Figure 7.1*).

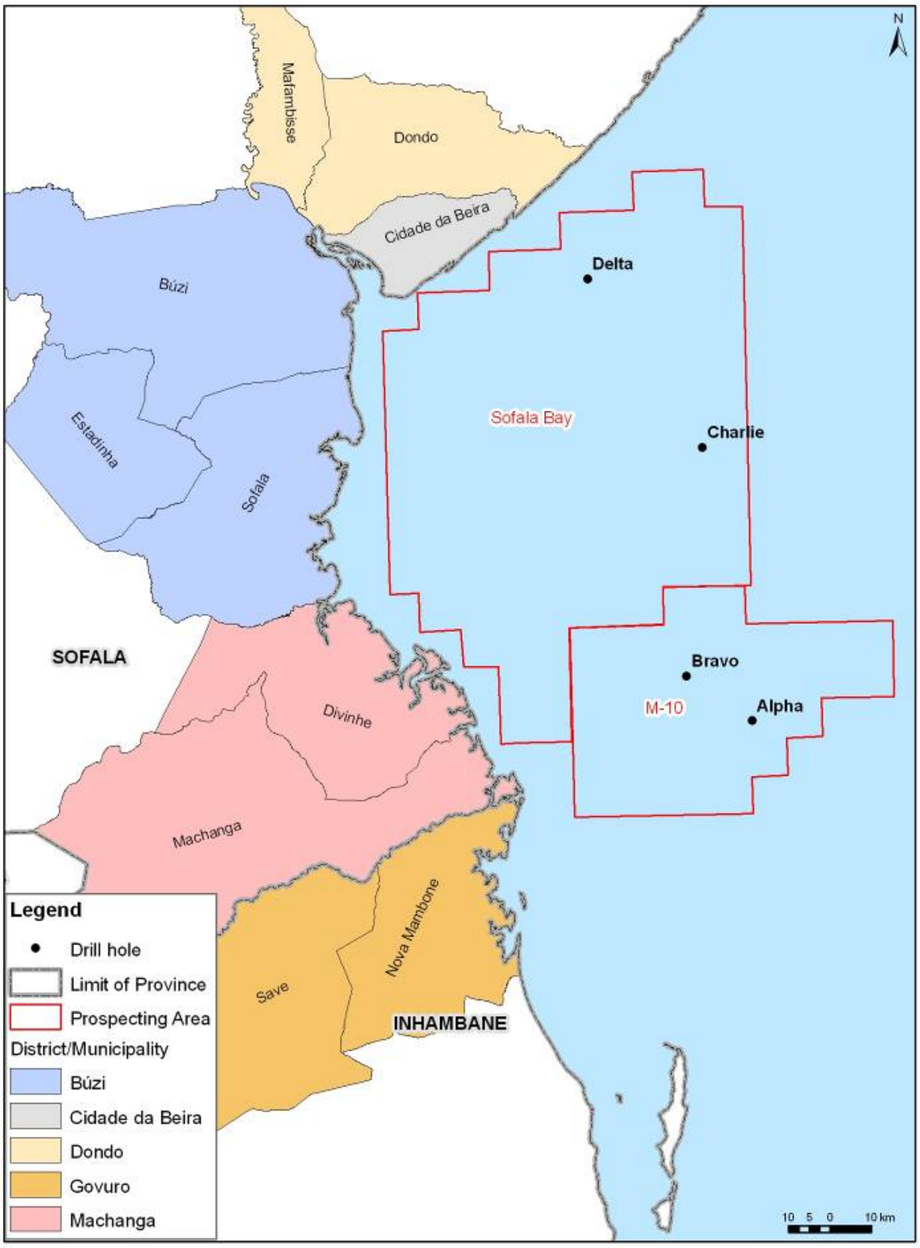
The broader Project Area has been described solely in terms of fisheries and tourism, and this includes the coastline between the Bazaruto Archipelago and south of the Zambezi River, including the Sofala Bank, covering the Districts of Inhassoro, Vilanculo (Province of Inhambane), Muanza, and Marromeu (in Sofala Province).

7.2 DEMOGRAPHY

7.2.1 *Sofala Province*

Sofala Province comprises 12 districts and three city councils. The city councils are Beira, Dondo and Marromeu. According to the 2007 census, Sofala Province has a total population of 1,642,636 inhabitants, representing approximately 8.1 percent of the total Mozambican population of 20,226,296. Sofala was ranked as the province with the fourth highest population in Mozambique, after Nampula, Zambezia and Tete Provinces, respectively, in 2007. According to INE (2009), between 1997 and 2007, the population of Sofala Province increased by 27 percent. The highest proportion of the population in Sofala Province speaks Cisena, followed by Cindau and Portuguese.

Figure 7.1 ***Administrative Districts Adjacent to the Project Area***



Sofala Province has a highly urbanised population, with 40 percent of inhabitants living in urban areas such as Beira and Dondo, and has the highest urban population density of all provinces (27.4 inhabitants per km²).

Population distribution in Sofala Province is strongly influenced by the location of transport routes and fertile soil. The highest population densities are found in the Beira Corridor and the fertile flood plains of the main rivers crossing the province. Just over half of the total population of the Province (51 percent) lives within the Dondo District in the Pungué River basin (INE, 1999). In contrast, less than 10 percent of the total provincial population resides in the southern districts of Machanga and Chibabava, which have the lowest population densities. The city of Beira has the highest population density with 671 people/km^2.

The population of the four administrative areas situated on the coast (Beira, Dondo, Buzi and Machanga) in Sofala Province is predominantly young with over 54 percent younger than 20 years, and with the 20-34 and 35-64 age groups accounting for 25 and 18 percent, respectively. Only 2.4 percent is over 64 years of age.

7.2.2 *Inhambane Province*

Inhambane Province comprises twelve districts and four city councils, namely Inhambane, Maxixe, Vilanculos and Massinga City Councils. The province has a total population of 1,252,479 inhabitants, representing approximately 6.2 % of the total population of Mozambique in 2007. According to INE (2009), the population of Inhambane Province increased eight percent between 1997 and 2007. Govuro District is the only district in Inhambane Province that occurs in the project area. It is the lowest populated region of Inhambane District with a population of 34,494 in 2007 (INE, 2009) and an overall population density of 7.3 people/km^2.

As in Sofala Province, the population is predominantly young with over 55 percent aged 0-19 years; 20 percent aged 20-34 years and 20 percent within the 35-64 age group. Five percent is over 65 years. Being close to Sofala, many young people leave for the City of Beira to pursue work and study opportunities, and there is a strong tradition of migration of men to South Africa and other Mozambican cities resulting in men representing only 44.5 percent of the population.

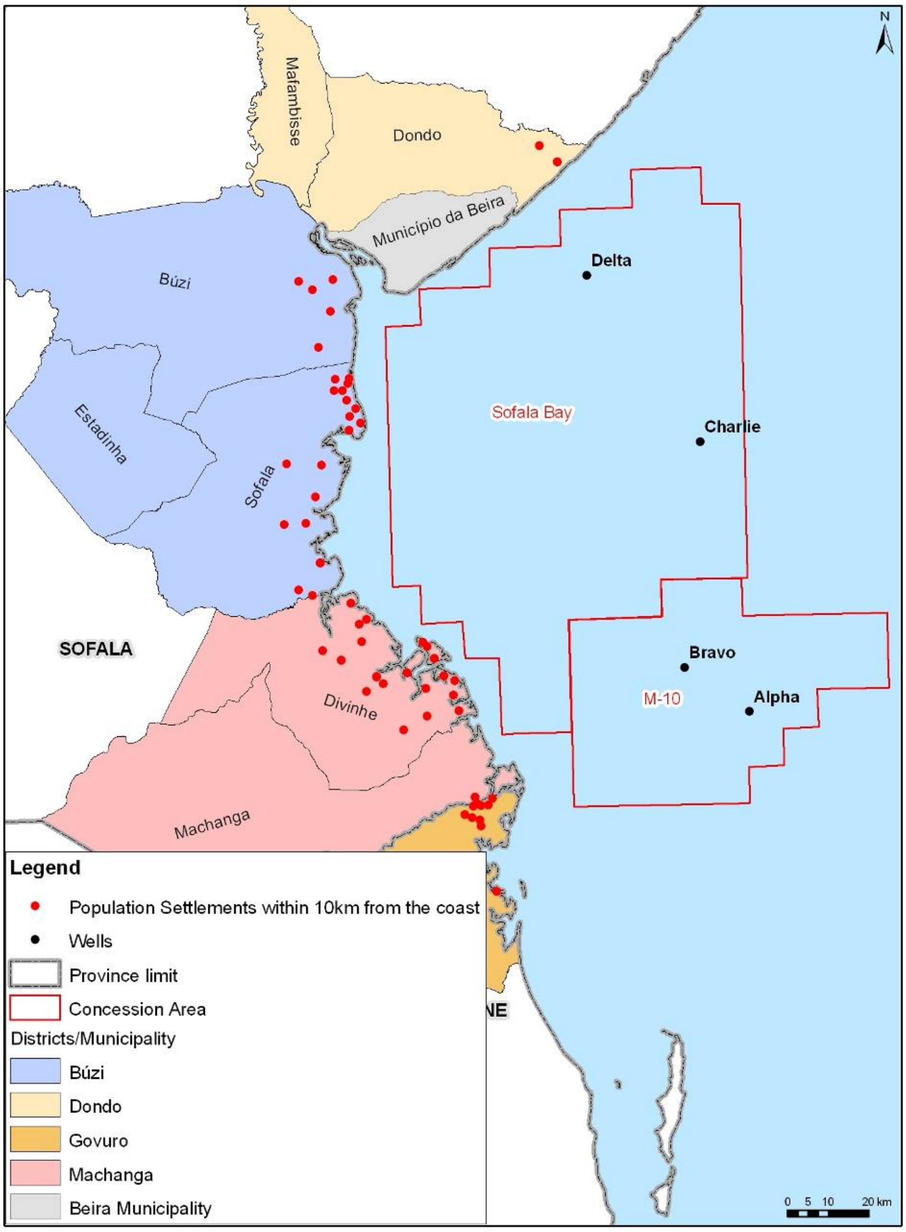
Agro-ecological conditions, as well as fishing and tourism opportunities, determine the population distribution of Govuro District. Most of its inhabitants are concentrated along the coastal areas and the fertile Save River floodplains. The most populous area is the Nova Mambone Administrative Post located at the mouth of the Save River with 60 percent of the District's population.

The southern districts of Inhambane District and the interior regions have a predominantly dry climate and poor soils, not offering favourable conditions for agricultural development, and therefore have low population densities.

7.2.3 *Overview of Settlement and Livelihoods in Sofala and Inhambane Districts*

A total of 64 rural settlements were located within 10 km of the coast based on 1999 data with a total population of 143,254 living in 29,780 households (*Figure 7.2*). Livelihoods are based on fishing which is important for food security, protein source and cash income. Subsistence agriculture is also important for growing staple food crops. An estimated 88 percent of rural residents derive their income from agriculture, fisheries and forestry in Sofala Province.

Figure 7.2 Population settlements within 10km of the coast



Inhambane is one of the poorest provinces in Mozambique with conditions for agriculture marginal due to erratic rainfall. It has a wealth of natural resources in the coastal zone on which the tourism and fishing industry depends, and which provides the basis for livelihoods for most of the population (84 percent).

The livelihoods of the majority of inhabitants in Sofala Province are based on fishing and subsistence agriculture (livestock and cropping), the latter having extremely low levels of productivity, and highly dependent on climatic factors. Fishing is an important source of food security and given its linkages to the oil and gas exploration and drilling industry it is dealt with in detail in *Section 7.3*. The main economic activities of the local inhabitants are household/ subsistence agriculture, charcoal production, wood collection and selling, fishing, informal trading and hunting.

Wage labour is a very low proportion of the economically active population at only 17.4 percent for Sofala and 9.3 percent for Inhambane, highlighting the huge reliance of the population on subsistence fishing and agriculture. Over 90 percent of the cultivated area in Sofala and 97 percent in Inhambane are cultivated as small agricultural plots, mainly worked by women, and averaging 1.5 ha in size. Cash crops accounts for only 10 percent of land in Sofala and 0.21 percent in Inhambane, suggesting income derived from rural households is very low.

With respect to agriculture, the five districts of the study area are located in areas with low soil productivity, low precipitation and in areas prone to cyclones. As a result, the area faces cyclical food security problems, with long periods of drought. Floods also occur regularly, causing major problems for the population living in rivers such as Save, Buzi and Pungue. Only these rivers have alluvium soil suitable for commercial agriculture although none is practised currently. Livestock rearing is a traditional activity and many households own cattle. Besides agriculture and fishing, rural residents rely heavily on other natural resources to supplement food supply and income, and which play a major role in livelihood strategies especially during drought periods. These include:

- Hunting and collection of palm wine;
- Production of reed and wood products (construction materials);
- Production of charcoal and firewood, which are mainly sold along the EN1 road;
- Artisanal production of stone for construction; and
- Fishing along the coast and in rivers and lakes in the interior.

Poverty data for Inhambane and Sofala Provinces in 2002 (IAF, 2003) is only available at Province level and not at district level making it difficult to compare data for coastal districts adjacent to the drilling concession area. Inhambane has the highest level of poverty at around 81 percent, far higher than the national average of 54 percent in 2003, while Sofala was estimated at 34 percent in 2003, down from 88 percent in 1997, suggesting some inaccuracies in the data. Poverty is most acute in the rural areas, where access to social services and infrastructure is also limited. It is anticipated that this poverty profile might be different in areas close to good fishing and tourism opportunities, which is expected to have created localised areas of lower poverty incidence.

In terms of access to services, a significantly higher number of households in Sofala have access to piped water (26.5 percent) compared to Inhambane (6.1 percent), while a significantly greater number of people in Inhambane Province rely on unprotected wells (54 percent) versus Sofala (31 percent). More people in Sofala have access to health services than Inhambane, probably largely related to the higher level of urbanisation in Sofala Province.

7.2.4 *Profile of Project Area Districts: Dondo, Beira, Buzi, Machanga and Govuro*

The project area is limited to Dondo, Beira, Buzi and Machanga districts in Sofala Province and the district of Govuro in Inhambane Province. This section provides more detailed demographic, livelihood and economic information. A summary of population data for the districts in the project area is contained in *Table 7.1*

Table 7.1 ***Demographic Data for Districts Adjacent to the Project Area***

Indicator	Dondo District	Buzi District	Machanga District	City of Beira	Govuro District
Total Population[1]	141,003	159,459	51,912	431,583	34,494
Number of people (settlements) within 10km of the coast[2]	4946 (3)	73,355 (25)	26,250 (24)	-	8247 (12)
Source[1]: INE 2009 Source[2]: INE 1999					

Dondo District

Dondo district is located in the central-eastern part of Sofala Province, in the western margin of the Pungue River, which discharges into the Indian Ocean next to Beira City. Dondo is divided into two Administrative Posts, namely Dondo-Sede and Mafambisse. Most of the population is located along the Pungue River and the Beira Corridor, and is engaged in rain-fed agriculture, growing maize, sorghum, millet, cassava and beans. Some monocultures of cash crops of cotton and sugar are grown. Some irrigation of small fields occurs along the Pungue River. Fruit trees include cashew, mango, guava, custard apple and paw paw.

Beira City

Beira is the capital of Sofala Province and the second largest town in Mozambique, containing almost a third of the province's total population. The City of Beira has the second largest concentration of industry in the country by virtue of its rail linkages and port services, and forms the basis for development of the Beira Corridor. Beira Port is the second largest in the country after Maputo in terms of handled shipping loads (see *Section 7.4*). The city is also characterised by intense commercial activity, both formal and informal.

The most developed areas of industrial activity in Beira are food processing, drinks, soap and detergents. The service sector is heavily represented in Beira, namely public administration services (Provincial and Municipal governments), representations of industrial companies, companies providing marketable services (eg agencies of services relating to the port, and consultancy and auditing companies), banks, and insurance companies, among others. The Sofala Province provides relatively large numbers of migrant labour to neighbouring countries, primarily for employment in ports and railways.

The Sofala Province benefits from the Sena Railway, linking the Port of Beira to Moatize in Tete Province, to Marromeu in Sofala Province and to the Republic of Malawi. In spite of not having been operational since the armed conflict, the Sena Railway retains its strategic importance and is under repair with a view to its renewed commissioning. The Sena Railway is a decisive factor of the development of Mozambique's Central Region and of the Zambezi Valley in particular. The Port of Beira is also connected to Machipanda in Zimbabwe, through the Machipanda Line that has remained operational.

In addition to these two lines, the Beira Corridor System also comprises a pipeline system transporting oil to Zimbabwe.

Buzi District

Buzi is the third most populous district in Sofala (after Beira City and Nhamatanda), and consists of three Administrative Posts, namely Buzi-Sede, Nova Sofala and Estaquinha. The current main economic activities in the Buzi district are agriculture, livestock and fishing.

The main economic centres are located south of the Buzi River where large commercial irrigation farming under Companhia do Búzi and Agri-Buzi are located. Main commercial crops grown are sugar, cotton and coconut but productivity could be higher with modernising and restructuring. The sugar factory and alcohol distillery ceased operation in the early 1990s and is currently obsolete, though there are attempts to reactivate development in the region.

The major fishing area of the Sofala Bank lies offshore of the Buzi District, which benefits from the productivity created by the outflow of rivers and the extensive mangrove swamps. See *Section 7.3* for more information on fishing.

Machanga District

Machanga District is located in the extreme south of Sofala Province, bordered from Inhambane Province by the Save River. Machanga is divided into two administrative posts, namely Machanga-Sede and Divinhe, the latter located in the northern part of the district and covering the largest coastal area of Machanga. Divinhe is subdivided into many localities and has the highest population density.

The district population represents only 3.2 percent of the total population of Sofala Province due to the very small areas with fertile soils where agriculture and animal husbandry is possible, located in the flood plains of the Save River. The interior areas are drier and a large area is occupied by the *Coutada de Caça* (hunting block) number five. The population of the Machanga District is mainly concentrated along the coast, where the main activities are agriculture, cattle rearing and fishing. The ratio of males to females is low within the district due to the history of immigration to South Africa and Zimbabwe.

Govuro District

Govuro District is situated at the north-eastern tip of Inhambane Province and is limited to the north by the Save River, a natural boundary with Sofala Province. It is the only district of Inhambane Province located in the study area. Govuro is divided into two Administrative Posts, namely Nova Mambone on the coast, and Save in the drier interior region. The Nova Mambone Administrative Post is located at the mouth of the Save River, occupying the entire district's coastal zone and is the most populous of the two, and with the highest population density. It is characterised by sandy clay soils and variable rainfall, and is highly vulnerable to floods, droughts and cyclones.

Fertile soils within the province are located in the flood plains of the Save River, where agriculture and cattle farming are practiced, mostly as small-scale farming. Cash crops are mainly cashew nuts, african mahogany fruit / mafurra (*Trichelia emetica*) and sugar cane. The interior areas are drier and covered by a large area of indigenous forest where the main subsistence activities are hunting, and harvesting of forest products.

7.3 FISHERIES

7.3.1 Overview of Sofala Bank Fishery

Fishing is the dominant activity along the coastal regions of the four districts within the study area focussed on the Sofala Bank, and supporting a significant number of the population. The Sofala Bank is a shelf region extending for over 900 km of coastline from Angoche District in Nampula Province to Save River mouth – the southern border of Sofala Province. The concession is located in the prime fishing area. A description of the fish found in the area is included in S*ection 6.4.3.*

Small-scale fishing is a prime activity in these districts, although there are also industrial and semi-industrial fishing operators in the Project Area, mainly in the Sofala Bank (Impacto, 2005 and 2007). The semi-industrial fishermen operate mostly from the Port of Beira. Prawns are the main target of the semi-industrial and industrial fishing activities.

The surface prawn industry comprises three types of operators:

- multinational operators (owning over half of the fishing quotas);
- individual foreign and domestic operators, who practice industrial fishing with the use of ice or onboard cold storage facilities; and
- traditional (small-scale) fishing.

Traditional fishermen catch the fish and process it on-land, while in industrial fishing the catch is processed and frozen onboard. Traditional fishing catch essentially fish (almost 97 percent) while industrial fisheries catch prawns, mainly surface prawns.

Of the industrial fisheries, one industrial fleet operates in the shallow water shrimp fishery, another in the deepwater shrimp fishery outside the continental shelf, and a linefish fleet operates in the Sofala Bank and in the southern shelf of Mozambique. A fleet of long-liners from the European Union operate offshore outside the territorial waters of northern Mozambique for tuna and similar fish. Mozambican fishing regulation (Decree No.43/2003) determines the zoning of the different fishing sectors, although some overlap among sectors can be seen. According to this zoning, industrial vessels operate from three nautical miles offshore, semi-industrial vessels from one nautical mile, while artisanal fishers can operate up to three nautical miles.

Some recreational fishing takes place south of the Project Area, closer to Bazaruto Archipelago.

7.3.2 *Small-scale Fishing*

Scale and Fishing Effort

There are two distinct areas of small-scale fishing activity with different characteristics:

- The Sofala Bank, covering the entire area between Moma, to the north of Nampula Province, and the Save River mouth to the south at the border between the Provinces of Sofala and Inhambane. This area covers the whole of Machanga district and a small part of Govuro District; and

- The area of the Bazaruto Archipelago National Park, which reaches the northern coast of Govuro district and the districts of Inhassoro and Vilankulo, and is therefore outside of the area of direct influence from the drilling project.

Artisanal fishermen are grouped in villages, called fishing centres, some of which are temporary and accessed with difficulty. For this reason, the censuses done by the IDPPE were never extensive and the numbers obtained are only estimates of the total number of fishermen and boats (Cawio, 1998, cited in Impacto, 2005).

The traditional maritime fishing census done by the Small Scale Fisheries Development Institute (IDPPE) in 2007 estimated that there were 116 fishing centres along the coast of Sofala (*Figure 7.3*) and 79 in Inhambane. The majority of fishing camps occur in Machanga and Buzi (Impacto, 2007), ie the coastal areas located closest to the proposed drilling concession. Although artisanal fishing is a year round activity, some migration of fishers does occur between fishing villages and from one province to another on a seasonal basis. The beach-seine fishery is closed for two months annually, usually from January, and includes the semi industrial and industrial fishery targeting shallow water shrimps. This is aimed at protecting juvenile shrimps of the main species - white prawn *Penaeus indicus* -by aiding their recruitment during summer.

The Sofala Bank has about 80,000 registered artisanal fishermen with and without vessels, a large proportion of which use beach-seines, gill nets, handlines, drag-nets, and trammel nets. Many of these are illegal in having non-selective mesh sizes and are used to target small pelagic fish, and incidentally catch juvenile shrimps in their nursery areas.

A total of 7,415 vessels were estimated in 2007 in the Sofala and Inhambane Districts with the greater majority (4,673 vessels or 63 percent) recorded in the districts near the Project Area (Dondo, Beira, Buzi, Machanga and Govuro) (*Table 7.2*). Beira, Machanga and Buzi contribute over 50 percent of the fishers and boats in the project area.

Figure 7.3 Fishing Centres Located Along the Sofala

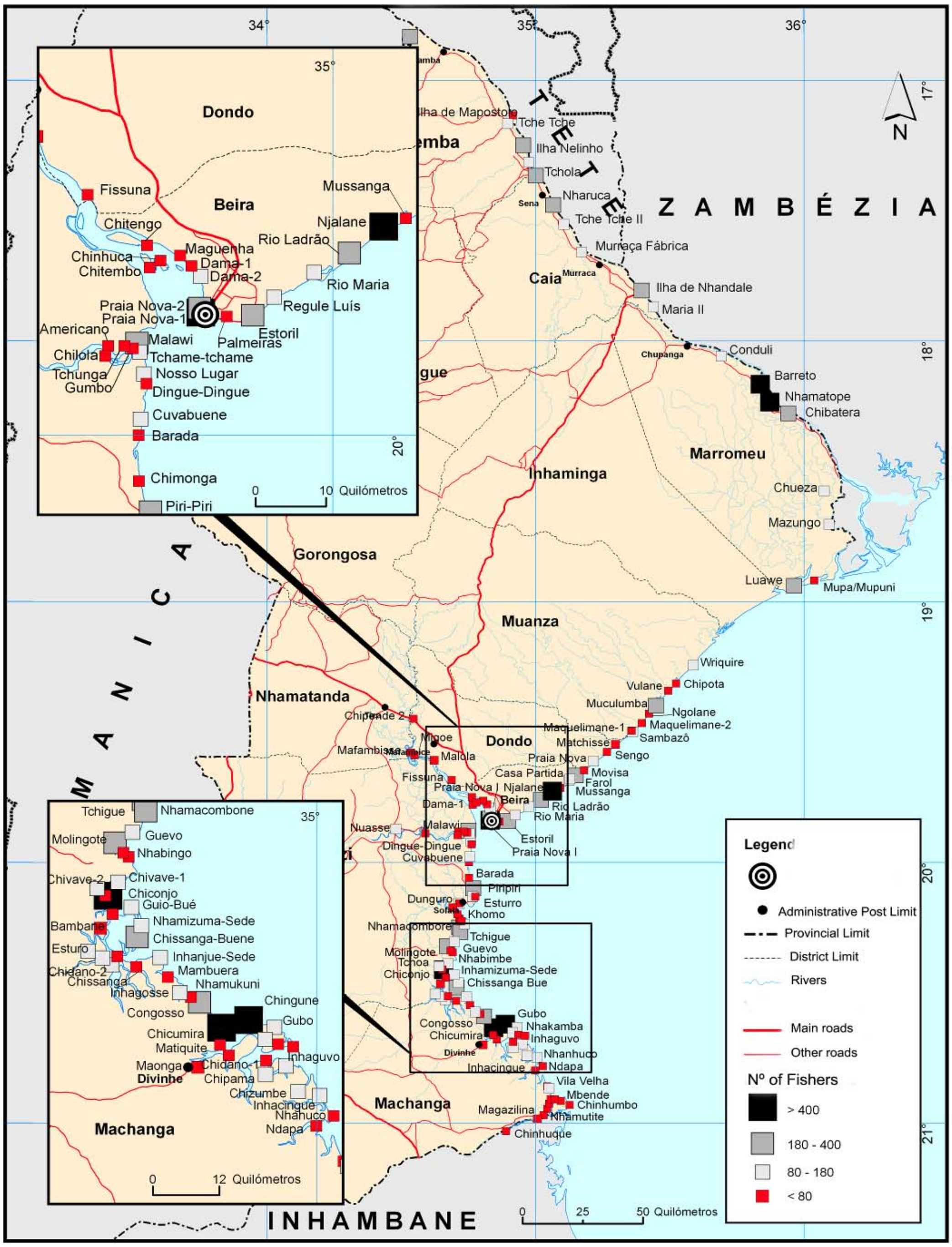


Table 7.2 Number of Fishermen, Fish Processors and Vessels by District in 2007

Province	District	Permanent Fishers	Non-permanent Fishers	Fish Processors	Vessels
Sofala	Beira	2,491	99	721	1,243
	Machanga	2,922	170	28	1,134
	Búzi	4,298	201	101	1,642
	Dondo	690	59	190	333
	Muanza	705	75	111	295
	Chiringoma	131	9	-	56
	Marromeu	3,942	66	76	1,344
Inhambane	B. de I'bane	278	71	5	202
	Vilankulos	1,988	1,032	59	540
	Inhassoro	1,400	1,158	128	305
	Govuro	996	273	102	321
Source: IIP 2009					

Data on the active fishing gear recorded in use during the census provides a more accurate indication of the intensity of fishing effort. This data shows correlation between the number of fishers per district and fishing effort as indicated by the active fishing gear in use (*Table 7.3*). Use of handlines, gillnets and chicocota (a fixed net similar to a beach-seine), was highest in Beira, Machanga and Buzi, although Machanga fishermen used more beach seines and less handlines than fishermen in Beira. Use of spears was high in Dondo and Muanza to the north of the project area.

Beach-seine netting requires at least 12 fishermen to operate and therefore is an important livelihood activity for a large number of the local community. Nets measure on average 14 m and are taken about 500 m from shore using a canoe and dropped into the water. The net is held open by a rope as the fishermen return to the beach where the net is pulled in by rope, a process that takes about an hour. Being non-selective, the nets catch a wide range of fish, mollusc and crusteaceans of all sizes, and is sorted by women, children and some fishers. Beach-seines are widely in use in northern Inhambane, in particular, catching 70 percent of the catch.

Gill nets, handlines and chicocotas require less labour (ranging from three fishers for gill nets to one for chicocotas) and have therefore become very popular. They require canoes and are mostly a passive form of fishing as gillnets and chicocotas can be left unattended for a few hours at a time.

Fishing mainly takes place from the early morning to lunchtime all weekdays, except Sundays, public holidays, days of mourning or in bad weather. Fishing does not occur on an estimated 19 percent of days for these reasons (Supinho, 2006).

Table 7.3 *Active Fishing Gear Counted in Each District in 2009*

Province	District	Beach Seine	Hand-line	Otter trawl	Chicocota	Gillnet	Long-line	Spear
Sofala	Beira	5,374	86,584	7,828	35,176	61,145	1,655	14,484
	Machanga	15,295	28,080	2,158	6,898	30,610	0	1,430
	Búzi	3,632	8,712	4,871	25,233	10,976	0	26,301
	Dondo	4,062	6,499	260	0	6,787	109	17,964
	Muanza	3,870	9,084	0	0	9,161	16	21,628
	Chiringoma	0	3,402	0	0	6,509	0	0
	Marromeu	1,887	5,691	0	0	7,911	0	0
Inhambane	B. de I'bane	14,159	26,711	0	0	14,642	0	0
	Tofo	0	8,340	0	0	471	0	0
	Vilankulos	36,625	10,731	0	0	3,081	0	0
	Inhassoro	15,803	7,691	0	0	0	0	0
	Bazaruto	3,443	98	0	0	0	0	0
	Govuro	3,743	0	0	0	13,023	0	0

Source: IIP 2009

Besides active artisanal fishers, the fishing industry also supports men and women involved in fish processing and resale (*Table 7.4*). Fish processing involves drying, salt drying, smoking, freezing, and resale of fresh fish. An estimated 1,142 people are involved in fish processing in the project area, though this may be under quantified.

Table 7.4 *Number of People Involved in Fish Processing by District*

		Type of Fish Processing					Processors		Total
Province	District	Drying	Salt drying	Smoking	Freezing	None (fresh)	Men	Women	
Sofala	Beira	13	16	7	12	8	485	236	721
	Machanga	43	44	9	10	10	16	12	28
	Búzi	41	43	34	31	11	101	0	101
	Dondo	3	7	4	5	3	175	15	190
	Cheringoma	-	-	-	-	-	-	-	-
	Marromeu	5	9	5	4	11	75	1	76
	Muanza	4	9	1	2	1	106	5	111
Inhambane	Govuro	11	13	11	12	11	71	31	102
	Inhassoro	10	12	10	11	12	121	7	128
	Vilankulo	2	14	4	3	4	8	51	59

Collectors of shells and crabs from the beach and inter-tidal areas are mostly women, who represent an important fraction of the fishermen. This is highest in Vilankulo District (approximately 850), compared to 32 registered in Govuro District.

Species Composition and Tonnage

Surveys in Machanga, Buzi and Beira coastal and offshore areas indicated catches comprise 80 fish species, 11 molluscs and 22 crustaceans of commercial interest (including those targeted in estuarine and freshwater areas – Pungue and Buzi Rivers). The most important fish species that make up 80 percent by weight of the artisanal fishery are: *Arius dussumieri, Hilsa kelee, Johnius dussumieri, Mugil cephalus, Otolithes ruber, Pellona ditchela, Sardinella gibbosa, Thryssa vitrirostris* and *Trichiurus lepturus.*

The most important mollusc in Sofala Bay is an intertidal clam found in sand banks near the Pungue River mouth: *Meretrix meretrix.* Other species of low importance both in quantity and commercially were *Mactra sp.* and *Donax incarnatus, Eumarcia paupercula* and *Donax madagascariensis.*

A total of 22 crustacean species have been recorded within the Sofala and M-10 Concessions, 14 of these were shrimps belonging to eight genera and five families, six crab species and two lobsters.

Of the estimated 22,427 tons of sea food caught by the artisanal fishery in 2009 in the 13 districts Inhambane and Sofala Provinces in 2009, the quantity caught in the four project area districts of Beira, Machanga, Dondo, Buzi, and Govuro comprised 64 percent of the total at 14,505 tons (*Table 7.5*).

Table 7.5 ***Total Catch (tons) by District of Commercial Fisheries from Artisanal Fisheries in 2009***

District	Penaeid shrimp	Non-penaeid shrimp	Fish	Crabs	Cephal-opods	Sharks	Lobster	Mix	Total
Beira	127.1	140.5	7,934.0	6.6	0.6	33.96	0.00	8.2	8,250.90
Machanga	64.5	1.7	2,759.2	0.0	1.1	1.63	0.00	3.1	2,831.20
Búzi	89.5	31.2	1,699.9	0.2	3.6	40.73	0.00	3.6	1,868.68
Dondo	11.1	18.4	735.2	0.0	1.4	32.81	0.00	21.1	819.99
Muanza	6.3	86.3	935.8	0.0	0.1	8.70	0.00	0.7	1,037.75
Chiringoma	0.4	0.0	321.0	0.0	0.0	7.26	0.00	0.0	328.67
Marromeu	5.1	15.2	550.6	0.5	0.0	1.82	0.00	0.1	573.28
B. de I'bane	69.6	0.0	1,186.3	65.8	9.7	0.26	0.04	27.9	1,359.62
Tofo	0.0	0.0	102.7	0.0	1.0	1.28	0.07	5.1	110.25
Vilankulos	13.3	0.0	2,491.0	274.6	83.6	1.81	0.98	17.9	2,883.19
Inhassoro	1.2	0.0	1,343.3	4.9	21.0	0.48	38.80	13.8	1,423.48
Bazaruto	0.1	0.0	199.7	0.1	2.4	0.01	0.00	2.0	204.17
Govuro	2.4	0.0	732.0	0.4	0.2	0.00	0.00	0.2	735.21
Total	**390.5**	**293.2**	**20990.6**	**353.0**	**124.8**	**130.8**	**39.9**	**103.6**	**22426.4**

7.3.3 *Semi-industrial and Industrial Fishing*

Economic Revenue

The fishery is Mozambique's second-largest export product after aluminium. The Sofala Bank fishery supports the main commercial fishery for penaeid shrimps valued at 80 million dollars per year in exports in recent years (or three percent of GDP (Palha de Sousa *et al*, 2006, 2009).

Vessels, Gear and Fishing Effort

The semi-industrial fleet is characterized by locally-owned vessels, most of whose owners have been facing financial difficulties in the past few years (Palha de Sousa *et al*., 2009). The industrial fleet, on the other hand, can be classed into two types of operators. The first is made up of joint venture companies between the Mozambican State and large multinationals based in Europe, and which are vertically-integrated and with sufficient financial means to support fleet renovation and to place the produce on the international market. These companies have between eight and 30 vessels each and exploit 70 percent of the Total Allowable Catch (TAC) and contribute the most to foreign exchange earnings. The second type is that of industrial companies using local capital, with a maximum of four vessels per company and with low productivity due to the obsolescence of their fleet and equipment.

Catch and effort data from the semi-industrial and industrial fleets operating within the project area and the Sofala Bank used in this baseline were obtained from sources which included sampling programs of the IIP at disembarkation points of vessels in Beira and in Chiloane island (Palha de Sousa *et al.*, 2009; Brito, 2005; da Silva, 2009).

The semi-industrial and industrial vessels fish primarily for shrimp and a variety of by-catch which supplies the local, regional and international markets with seafood. The semi-industrial fleet can operate from 1 nautical mile offshore and the vessel sizes vary from 10 to 20 m in length. Catch is preserved on ice and vessels return to port each day. The industrial fleet comprise freezer vessels that can operate continuously over three weeks or more and are at least 20 m in length. A summary of vessels and catch in tons operating in the project area is contained in *Table 7.6.*

Table 7.6 Number of Vessels and Catch (tons) by Fishery in and Around the Project Area in 2009

Fishery	Industrial	Semi-Industrial	Artisanal
Shrimp	58 (4,994)	35 (110)	24 (10)
Deep water shrimp	16 (1,163)		
Fish (line fishery)	18 (83)	27 (734)	
Tuna	155 (,3087)		

Source: Ministry of Fisheries 2010

There were 35 semi-industrial otter trawlers in the southern Sofala Bank in 2009, and another fleet of 24 vessels regarded as artisanals operated in the area. The artisanal vessels referred to here are normally about 9 m in length but may have a comparable fishing capacity to the actual semi-industrial vessels (Ministerio das Pescas, 2010). These fleets fish for around 10 months a year and have a closed season for the summer months of January and February. Note that this number of artisanal vessels does not relate to all the vessels used in the artisanal fishery described above in *Section 7.3.2.*

An exclusive zone for the semi-industrial otter trawlers was created by a ministerial dispatch in 2003. This zone is located from Savane (19°47'S in Dondo district) to Save river mouth (21°00'S) and spreads offshore to a limit set by a nearly straight line following the 35°11'E longitude, thus overlapping slightly with the Sofala and M-10 Concessions (*Figure 7.4*).

A total of 58 industrial vessels were dedicated to commercial fishing for shallow water shrimps on Sofala bank in 2009, while a further 16 vessels fished for deep water shrimps outside of the continental shelf. Another fleet of 18 industrial vessels operate within or outside Sofala bank and specialize in line fish for finfish (Ministerio das Pescas, 2010). These industrial freezer fleets which focus on the export market are mainly based in the city of Beira (about 70% of the fleet) while the remaining vessels use Quelimane or Maputo city as their home base.

Fishing Season and Depths

Sofala Bank shrimp trawlers typically spend most fishing effort at depths shallower than 25 m throughout the year where they obtain the highest catches of "banana" shrimps (*Pennaeus indicus* and *Metapenaeus monoceros*). In the first two to three months of the fishing season, there is a similar intensity of effort in the day and at night, which then increases in deeper areas (25 to 70 m) and increases at night towards the latter half of the season as 'banana' species become less abundant. The most intense prawn fishing season is March to May, during which over 50% of the annual catch is caught (Brito, 2010).

Deep sea shrimp fishing is undertaken by the industrial fishing at depths varying between 200 to 800 m and between latitudes 17°S and 25°40´S, at least 30 km to the east of the Sofala Concession (*Figure 7.4*).

A further 155 European-flagged vessels are licensed to fish for tuna to the north of Sofala bank and report their catch in their home countries. Vessesls involved in the tuna fishery in the western Indian Ocean pursue their target fish species along annual migratory routes, travelling through several Exclusive Economic Zones (EEZs) including Mozambique, Tanzania, France, Comoros, Madagascar, Mauritius, Seychelles and South Africa. These vessels are, therefore, not present in any one EEZ all year round, as their fishing location will depend upon the concentrations of target species. This will be influenced primarily by the location and abundance of fish prey (small pelagic fish, cephalopods).

Both linefish fleets operate year-around, while the industrial shrimp vessels operate about six to nine months a year. During the previous two years a closed season of six months, starting in September, was introduced as a means of lowering increasing operational costs in months that yields lowest catch rates (Brito, in press).

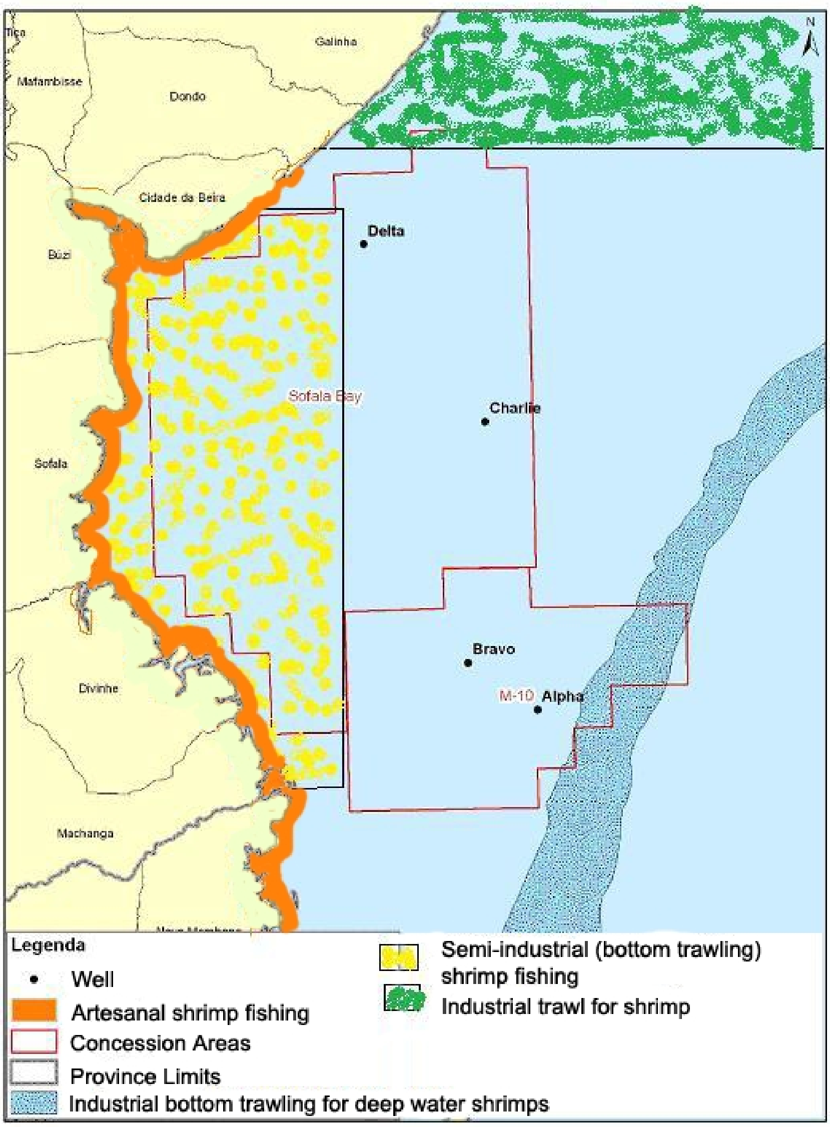
During 2009, a total of 110 tons were landed by the semi-industrial shrimp vessels that operate in the project area and surroundings, while the freezer trawlers (industrial) reported a total catch of 5,017 tons (Ministerio das Pescas, 2010). It is important to note that in any given fishing season all vessels in the fishery will not operate at all times due to problems which include maintenance, financial and other administrative issues that prevent them from fishing, thus the catch reported in *Table 7.6* may not correlate with the number of vessels shown.

Principal areas of industrial and semi-industrial fishing activities in relation to the project area are shown in *Figure 7.4* below.

7.3.4 Recreational Fishing

Recreational fishing for sports fish (eg marlin, Spanish mackerel, sail fish) in the project area is undertaken predominantly by amateur fishermen and mostly takes place south of the Save River (latitude 21°S) in Inhambane Province, and therefore outside of the drilling concession area. Here, around Bazaruto Islands, snorkeling on the coral reefs is also a popular activity.

Figure 7.4 Location of Semi-industrial and Industrial Fishing Activities in Relation to the M-10 and Sofala Concessions



Institutional Support for the Fisheries Sector

Various institutions and projects play a role in governance and support to the fisheries sector in the project area. These include:

Institute for Fisheries Investigation - A public institution for investigation with delegations in Inhambane and Sofala provinces.

Fisheries Foment Fund - A public institution involved in the management of loans granted to artisan/subsistence fishermen with delegations in Inhambane and Sofala provinces.

Institute for Development of the Small Scale Fishing - Dedicated to the promotion of the development of small-scale fishing in view to improve the living and work conditions of communities involved in the activities as well as improving the national level of production protein-rich sources of food. The institution has delegations in the Inhambane and Sofala Provinces, Beira City and the Inhassoro District.

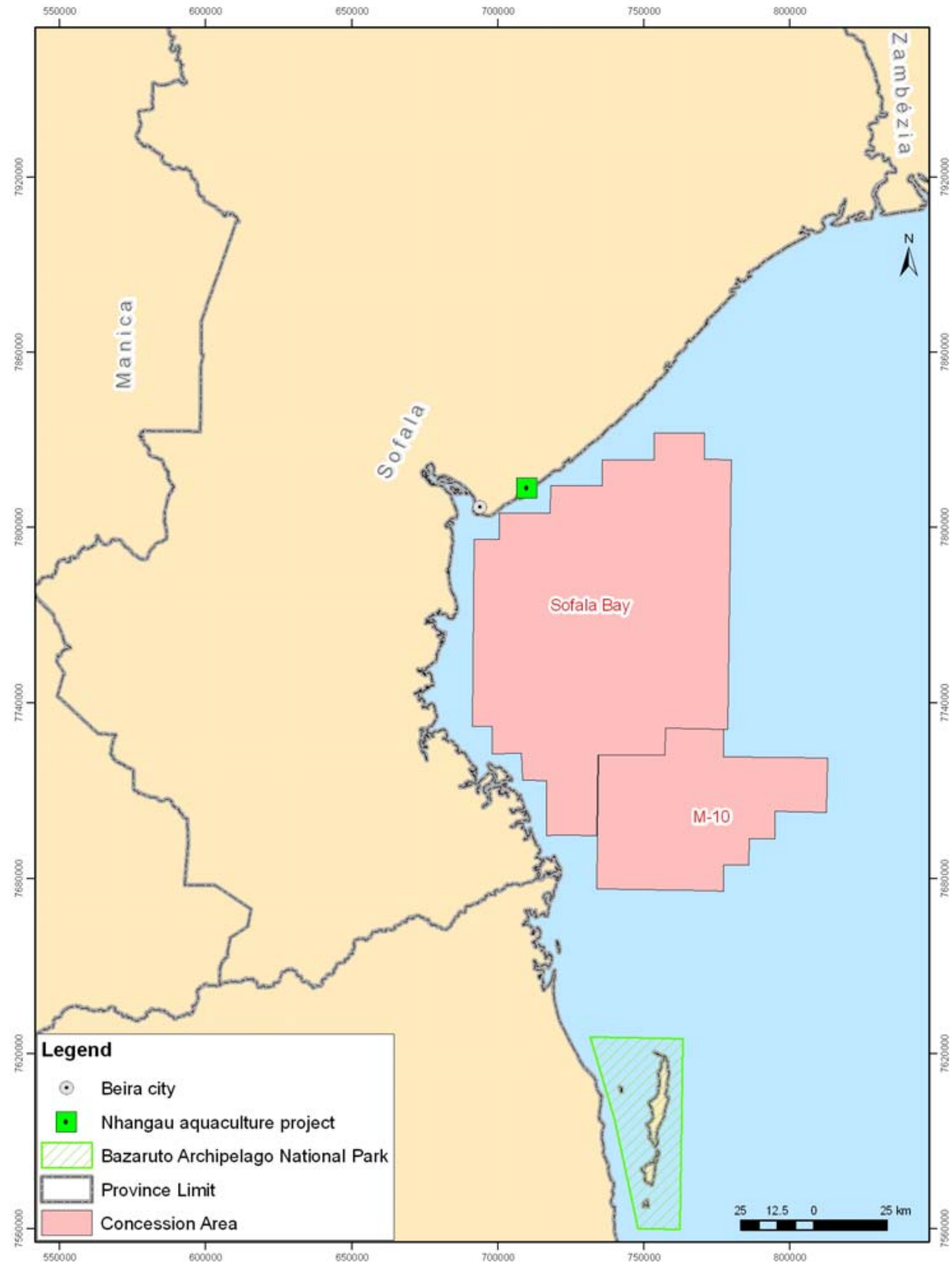
Artisan Fishing Project in the Sofala Bank - This project is a sub-component of the Development of the Small Scale Fishing Project which aims to improve the socio-economic conditions of the fisher communities of the Sofala Bank and the zones between the Mongicual District, located in the northern Nampula province, and the floodplains of the Save River located in the South. The project is funded by International Fund for Agricultural Development (FIDA), the Norwegian Agency for Cooperation and Development (NORAD) and Belgian Fund for Subsistence (BSF).

Fisheries Associations - Composed of organised fishermen with common objectives. Some of these associations such as the Ufumi Wedu and Marcelina Chissano Associations (in Machanga and Govuro, respectively) were revitalised or formed following the 2000 cyclone and the 2001 floods. Some of the existing associations are involved in the buying and processing of the fish from non-members, therefore playing an important role in the commercialisation of the fisheries within the fishing community.

7.3.5 Aquaculture

There is one prawn aquaculture project in the coastal zone of the study area at the Nhangau coast, Sofala Province (*Figure 7.5*) operated by Sol and Mar (*Sociedade Sino-Moçambicana de Aquacultura e Pesca*). The aquaculture project is situated in a coastal area, approximately 15 km northeast of Beira City (Sofala Province) and occupies an area of approximately 500 hectares. The project area is situated in Nhangau locality, next to the Maria River, in a section between Maria River and Savane River and is therefore in close proximity to the study area, (8 km from the Sofala Concession) (see *Figure 7.5*). The species selected for this culture, *Penaeus monodon* (tiger prawns) is abundant in the Sofala Bank and in farming systems presents high growth and productivity indices. Prawn production at the Nhangau exceeds 1,000 tons per year.

Figure 7.5 *Aquaculture Project in Nhangau Relative to the Study Area*



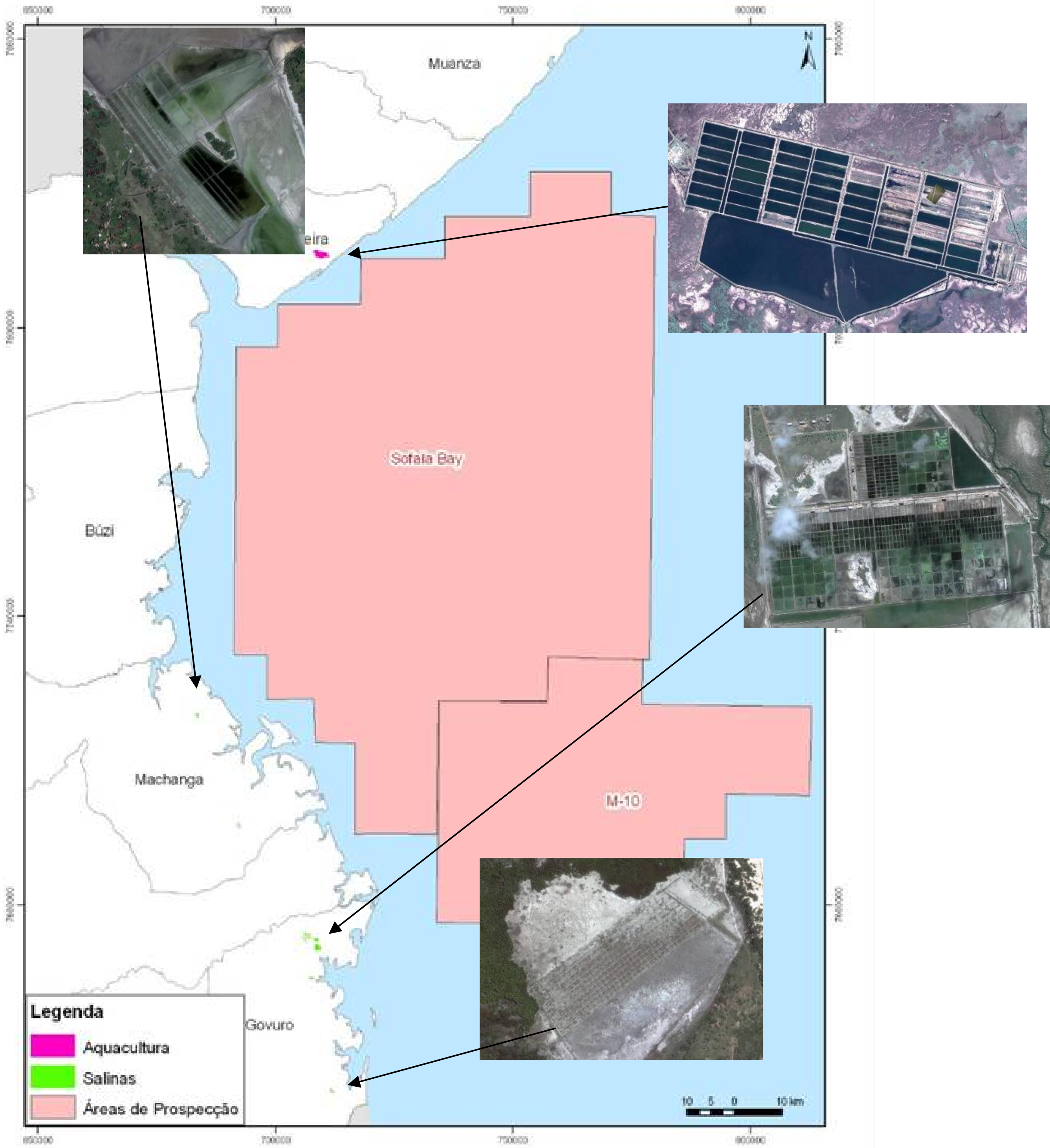
7.3.6 *Salt Pans*

Approximately ten salt pans are located in the coast of Govuro (mainly in the areas called Maheme and Chimunda) and in Machanga (*Error! Reference source not found.*). North of these, only Quelimane in Zambézia Province has salt pans.

The salt pans are all located along the coast (less than 2km from the shore) and they employ approximately 30 permanent people and 100 seasonal workers during production campaigns, which take place in the dry season (generally between August to November).

Most of the salt pans are operated by families or fisherman, and the salt is used for consumption and to sell in local markets as well as in Beira, Chimoio and Tete. Families tend to have an average area of 40 – 50 ha each.

Figure 7.6 *Salt pans in the Vicinity of the Project Area*



7.3.7 *Tourism*

Tourism Overview

In contrast to the tourist interest zones of Cabo Delgado, Niassa, Nampula and Inhambane in the south of Mozambique, tourism is almost non-existent in the coastal areas of Govuro, Machanga, Buzi and Muanza Districts. However, the Sofala area has been identified as one of the 17 Priority Areas for Tourism Investment (PATI) in the National Tourism Policy and Implementation Strategy (Ministry of Tourism, 2003, 2004) (*Figure 7.7*) with key tourism products identified as urban, beach and cultural tourism and coastal eco-tourism. Due to generally turbid waters, tourism centred on diving and snorkelling is not viable, and this activity is the focus of the Bazaruto Archipelago area to the south. In general, the coastal region is highly undeveloped for tourism, also partly attributable to the extensive swathes of coastline covered with mangrove forests, the paucity of good swimming beaches, and the significant wave height differential between low tide and high tide leaving extensive reaches of the bay without water at low tide.

The Gorongosa National Park (GNP) (120 km northwest of Beira) and Marromeu Buffalo Reserve, eight hunting areas (including Coutada Five)and three forest reserves and 300 km of coastline offers considerable potential for local and foreign tourism. The GNP is regarded as the single biggest tourism attraction in the region which is due to be expanded to 4,067 km^2 to include the Gorongosa mountain range, and around which several leading international safari, hotel and tourism operators are preparing proposals for seven areas in the park.

Accommodation, Employment and Revenue Generation

Current accommodation facilities in Beira and the Districts of Muanza, Buzi and Machanga include 48 establishments providing 675 rooms with a total of 1,041 beds. Only seven establishments are located on the coast, all within the City of Beira, and provide 68 rooms with a total of 121 beds and employing 63 people. A new 192 room 4-star hotel with casino and conference centre is being constructed in Beira to meet the need for quality buisiness and leisure hotel facilities. The Macuti Lighthouse has been acquired for development.

Inhambane Province, in contrast to Sofala Province, is the second largest tourism destination in Mozambique (after Maputo), with a high concentration of tourism establishments and tourism activities centred on the coastline. Between 2004 and 2008, the Province received US$260.3 million in direct private investment in the tourism sector, predominantly from foreign investors. This investment increased the number of accommodation units from 270 in 2004 to 431 in 2008, and together with local initiatives and investment, led to the creation of 20,000 jobs. The Vilankulo/Bazaruto zone tourism industry benefits from the presence of an international airport at Vilankulo, improved electricity, communications and road network, and the declaration of the Bazaruto Archipelago as a National Park (BANP) and World Heritage Site. There are 260 beds in five establishments in the BANP, aimed at the low impact, high quality tourism sector. An additional 20 to 30 percent of visitors are day visitors, predominantly for snorkelling, diving and fishing activities. Approximately 25 percent of the Island's population of 3,500 benefits from tourism-related activities, and all of the resident population rely on subsistence fishing for their livelihoods and protein source.

On the mainland, the Vilankulo Coastal Wildlife Sanctuary on São Sebastião Peninsula and surrounding waters represents the first national attempt at privatising conservation. An offshore commercial entity was granted development rights for low density tourism and the establishment of 100 commercial beds in safari style lodges and 50 residential plots for commercial and private use.

Peak use of the area coincides with school holidays in December/January, April and August/September.

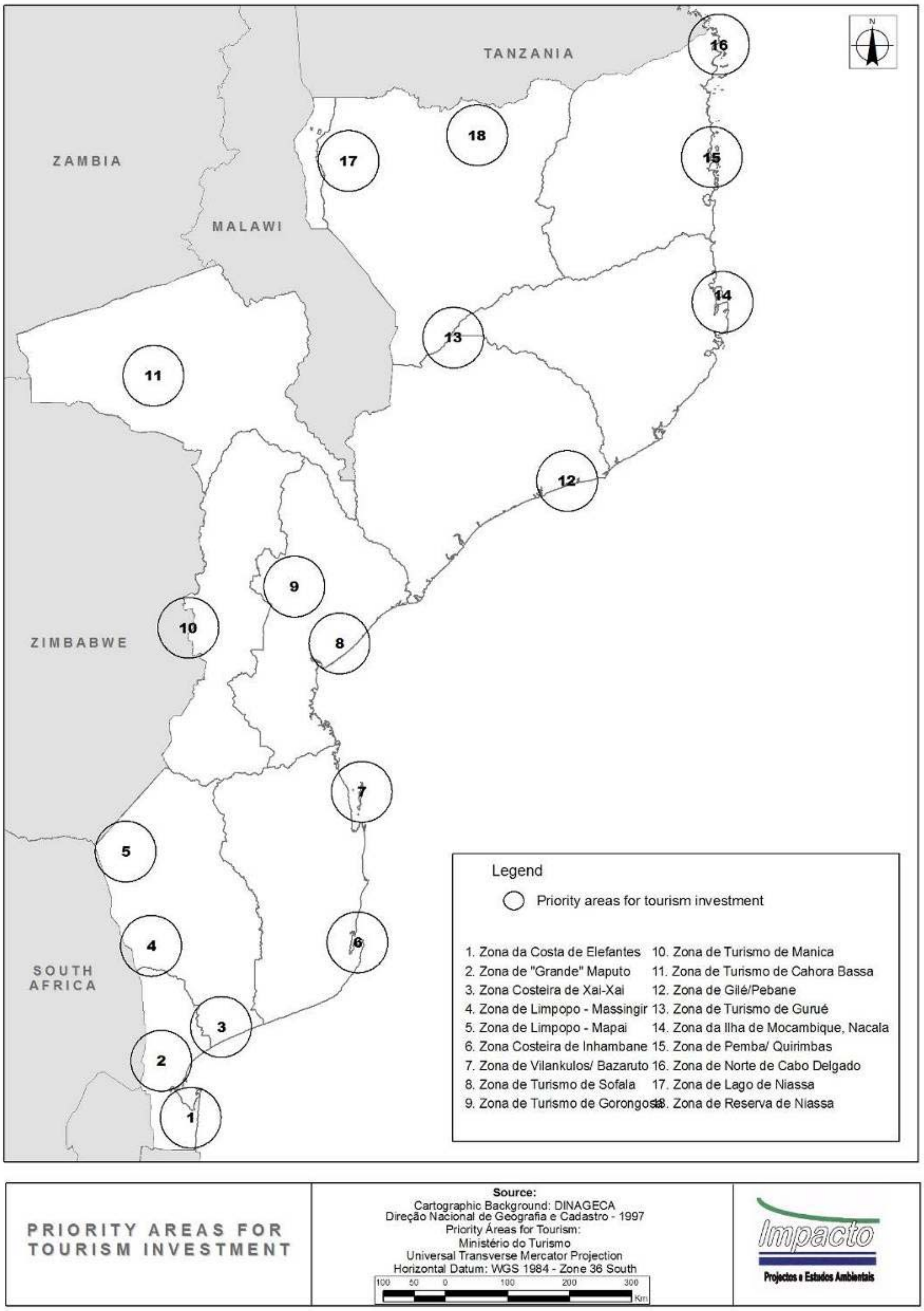
The tourism industry is the largest formal sector employer in the coastal regions of Inhassoro and Inhambane in the broader project study area with approximately 1,560 people employed in 2005. Employment of islanders in Island establishments remains low – about 10 percent of staff, and there is a recognised need to train local community members.

Turnover generated by the approximate 1,798 beds in tourism establishments in Inhassoro and Vilankulo districts in 2005 was calculated to be in the order of US$17.5 million. This was based on reported occupation rates and calculations on food consumption and value of other third party goods and services. The value of goods and services from suppliers to the tourist industry was estimated at approximately 31 percent of the value of income to tourism facilities in Inhassoro, and 57 percent in Vilankulo.

Key Tourism Activities

Main attractions are diving and snorkelling with the most popular dive sites being the northwestern side of Magaruque, Two Mile Reef, Five Mile Reef, the Potholes, the Greek Temple, reefs along the eastern side of Bazaruto Island and the Coral Gardens in the north. A key advantage of the area is that the reefs are very easily accessible and provide for a range of diver experience levels. Twelve Mile Reef, located about 60 km south of Sofala Concession is mainly visited by divers from the Archipelago lodges but is also a key deep sea fishing area. The best diving period is April to December, while deep sea fishing events (involving 30-60 boats) take place in April, December and January. Most recreational fishing for billfish takes place north of Bazaruto Island, sometimes up to 20 km from shore.

Figure 7.7 Location of the Priority Areas for Tourism Investment



7.4 SHIPPING

7.4.1 *Overview of Shipping in the Sofala Bay Area and Port Usage*

The marine area between Sofala and Maputo comprises an important shipping traffic area. Shipping traffic in deeper water further from the coast tends to connect northern ports such as Nacala and Maputo, as well as international ports. Fishing vessels or commercial ships travel closer to the coast between the Ports of Quelimane, Beira, Inhambane and Maputo. Approximate vessel transport routes are shown in *Figure 7.8* while the City and Port of Beira are pictured in *Figure 7.9*.

The Maritime Authority (the National Maritime Institute - INAMAR) indicated that an average of 1,000 cargo and fishing ships cross the project area at a distance of 20 to 35 miles from the coast annually, mostly in transit through the Mozambique Channel. The Port of Beira largely handles the import and export of goods to and from Zimbabwe, Malawi, Zambia, South Africa and other countries in the region (Ports and Ships, 2005). With Zimbabwe being a major historic user of the Beira Port, the economic and political crisis in Zimbabwe in recent years has contributed to a decline in cargo vessels carrying goods to or from this country. In 2005, the shipping traffic between the ports of Beira and Maputo decreased substantially with an average of 43 vessels recorded for 2005. This fluctuation is attributed to political instability in Zimbabwe.

According to the Administração Marítima (in Entrix (1998), 1,130 cargo vessels moved into and out of Beira harbour between January 1997 and April 1998, equivalent to an average of 71 vessels arriving or departing per month. They varied in length from 30 to 210 metres. Vessels with a length of between 90 and 180 metres comprised 72 percent of the vessels using Beira harbour during this period.

Figure 7.8 Main Shipping Navigation Routes in the Project Area

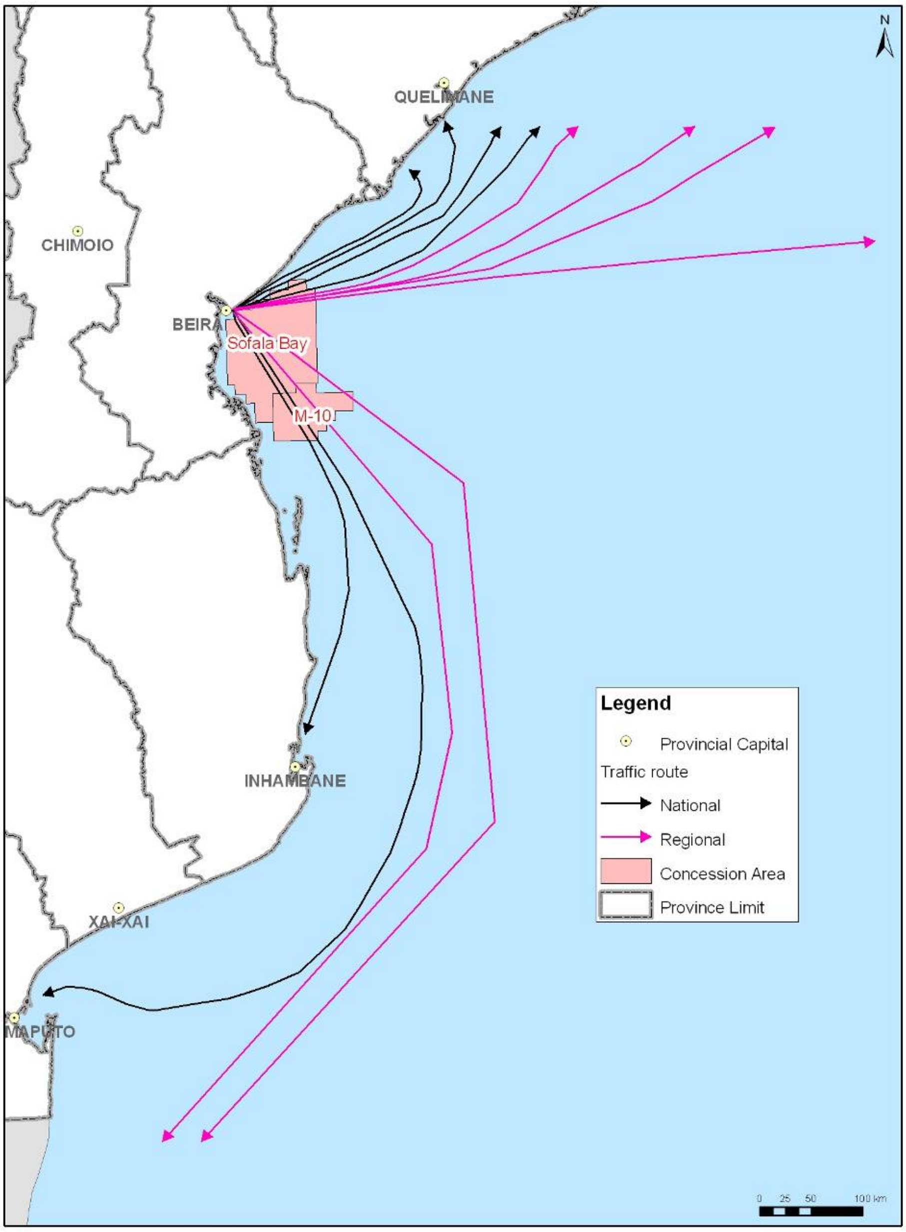


Figure 7.9 ***Aerial image of the City and Port of Beira, showing the Fishing Port in the middle and the Port of Beira on the Bank of the Pungue River***

Source: Consultec 2007

7.4.2 *Types of Shipping and Vessel Movements*

The Port of Beira has a greater degree of shipping in the project area as all categories of marine traffic make use of the port, namely: International Shipping, Domestic and Regional Cabotage, Small Scale Transport, Fishing Vessels and Tourism Vessels. *Table 7.7* summarises the number of vessels using the port in the different cabotage classes for 2009.

Table 7.7 ***Volume of Traffic of National and Regional Cabotage for the Port of Beira in 2009***

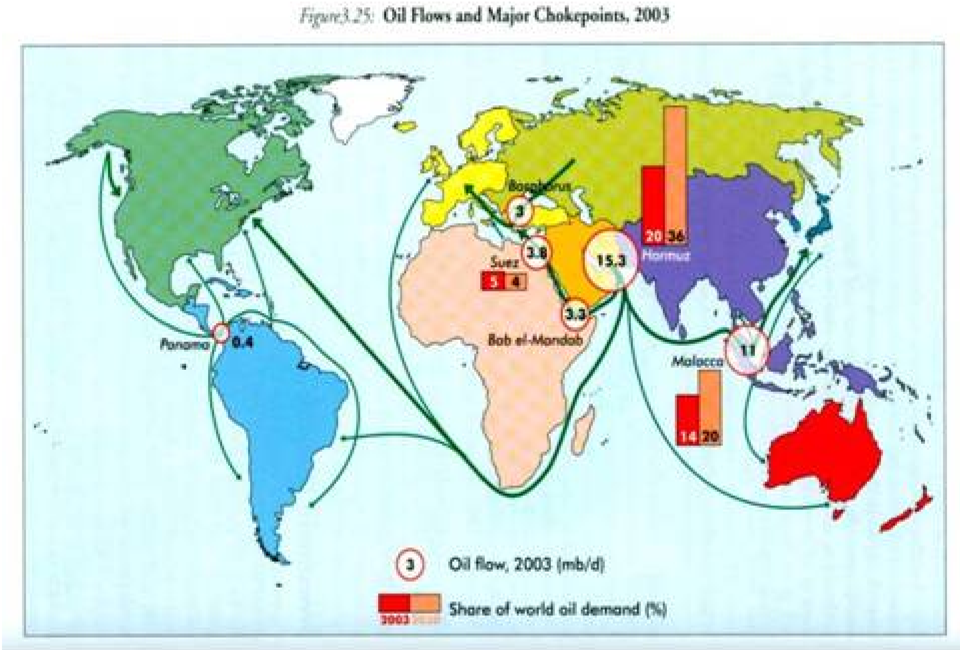
	With National Ports	**With South African Ports**	**With Other Regional Ports**	**Global Total (2009)**
Number of Vessels	49	65	44	158
Percentage	30.5	42.5	27	100

Source: Administração Marítima da Beira (Beira Maritime Authority)

International Shipping

International vessel movement includes shipping traffic from Europe, Asia and the Americas, as well as some non-regular traffic from North Africa, the Horn of Africa and other parts of the world *(Figure 7.10)*. Much of the traffic through the Mozambique Channel comprises oil tankers passing through at greater distance from shore than the proposed drilling activities.

Figure 7.10 ***International Shipping Transit Routes (Mainly Oil Tankers) Showing Passage Through the Mozambican Channel***



Source: Marine High Way Project in the Mozambique Channel

Transit Traffic

This category of traffic includes ships transiting the Mozambique Channel, connecting the Far East and the rest of the world, comprising mainly oil tankers and general cargo ships. Transit traffic remains outside the project area of Sofala Bay.

Domestic and Regional Cabotage

Includes traffic from other national ports and from countries in the region such as South Africa (mainly trans-shipments from the port of Durban), Madagascar (mainly from the port of Tamatave), Tanzania (mainly from the port of Dar-Es Salaam), and Kenya (mainly from the port of Mombassa).

Small Scale Transport

This category of traffic includes small passenger vessels connecting the City of Beira with some villages such as Buzi, Chiloane (Island), among others. Small passenger vessels also connect the various Islands of the Bazaruto Archipelago with the main land (Vilanculos, Inhassoro and Nova Mambone) to the south of the project area.

Fishing Vessels

This category of traffic includes Industrial and Semi-Industrial Fishing Vessels which use the port of Beira as a base port due to its proximity to the Sofala Bank fishing area. A large number of small-scale fishing vessels, numbering about 7,400, are also involved with artisanal fishing in Sofala Bay, generally within three nautical miles of shore.

Tourism Vessels

This category of traffic includes cruise ships, yachts and small pleasure boats. Cruise ships and yachts undertake temporary visits to the Bazaruto Archipelago, while the small pleasure boats are in the area on a permanent basis. Generally, tourism vessels are mainly concentrated in the Bazaruto Area around the islands, rather in the Project Area.

Durban is regarded as the *"Mother-Port"* for the Southern Africa region and accounts for the majority of traffic on the eastern seaboard, including traffic to and from the ports of Durban and Richards Bay. National cabotage in Mozambique accounts for the second tier of marine traffic in the region, involving traffic between Beira-Maputo and Beira-Quelimane, followed by traffic between Beira and other national ports of Pemba, Nacala, Angoche and Inhambane. Additional traffic in the region is accounted for by traffic from other regional ports Mombassa (Kenya), Dar es Salaam (Tanzania), Moroni (Comoros) and Tamatave (Madagascar).

7.4.3 Beira Port

Management and Capacity of Beira Port

The management of the Port of Beira is divided in two parts:

- the container terminal and the general load terminal, under concession management of the private company Cornelder;
- the petroleum and coal terminal and the fishing harbour, under management of CFM.

The cargo management capacity of the port of Beira is about 7 million tons per year, not including the terminals of petroleum, fuel and coal (with an estimated capacity of about 4.5-5.0 tons a year). As indicated, this capacity is expected to increase with improved dredging to increase the size of vessel that can enter the port.

The port of Beira is essentially a transit port for loading and unloading cargo for neighbouring countries and Mozambique's national commerce. About 60 percent of cargo handled is to or from Zimbabwe, while Malawi and Zambia also use the port (10 percent of total cargo) (SWECO 2004). The volume of goods handled by the Port from 1975 to 2004 is shown in *Figure 7.11*.

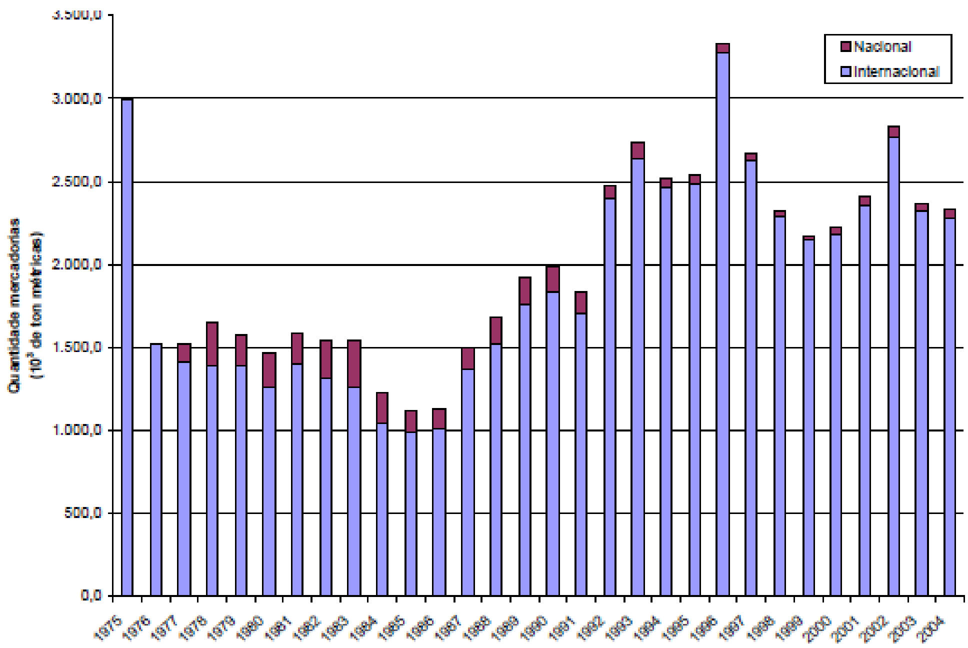
In 2006, despite the downturn in the Zimbabwean economy, the Port of Beira handled 78, 400 metric tonnes of goods, followed by 38,600 for Mozambique, 19,300 for Malawi, 6,500 for Zambia and 9,500 for other countries.

The annual capacity of the Port of Beira is close to 2.3 million tonnes of cargo, without including the fuel terminals (close to 2.0 million tonnes) and coal (close to 3,000 tonnes). The current storage capacity of the tanks is 18,000 tonnes per year. The container area has an annual capacity of 4.7 million tonnes (Consultec 2007).

Products handled in the Port include cereals, cotton, citrus products, tea and coffee, prawns, vegetable oils, tobacco, cement, ornamental rocks such as granite, wood, metals (copper, iron rods, chrome), various types of containers and vehicles (Consultec 2007). In the 1990s the transit of cargo was mainly international and more than 50percent of the products were derived from oils (JICA 1999 in Consultec 2007).

The table below shows values relating to the cargo in the Port of Beira in June 2006 (Consultec 2007). As can be seen, despite the economic crisis in Zimbabwe the highest proportion of the cargo still goes there, followed by products for national commerce.

Figure 7.11 ***Volume of Goods (in 10,000 Metric Tons) Processed at Beira Port between 1975 and 2004***



Source: Consultec 2007

Maintenance of the Access Channel to the Port of Beira

Port activities are dependent on the functioning of the 27 km access channel and the free transit of ships that use the Port. Due to the high level of sediment that continually flows into Sofala Bay, periodic dredging of the navigation channels is fundamental to the Ports operation. However, high sedimentation rates of of close to 2.5 million cubic metres annually, combined with constraints in dredging maintenance in the Port Access Channel (created in 1988) has limited the optimal functioning of the Port of Beira (Consultec 2007).

In its original state the channel (which has a depth of -8.0 m) allowed for ships of up to 50,000 DWT of weight. However, through sedimentation the Port can only receive ships of up to 20,000 DWT at high tide (reaching up to 25,000 DWT in spring tides). The channel depth has decreased from -8.0 m to -4.0 m and has a varying width of 135-200 m to 75 m in most of the channel, reduced from an original width of up to 250 m.

The variation of the water level in the Port of Beira region is close to 6.7 m, with a minimum value of 0.6, and a maximum of 7.3 m between the peak of low tide and high tide respectively. These significant vertical variations of sea levels leads to a high sea incursion far into the Beira estuary and cause strong tidal currents, responsible for the high rates of sediment transportation in the region.

In 1996, about 86 percent of ships coming to the Beira Port had to wait for higher tides of 6.5 m to enter the Port facility. In 2000, the number of cargo ships visiting the Port had increased by 61 percent but so did the "tide waiting time"due to sedimentation of the access channel.

The trend towards ever-increasing sizes of ships to improve the efficiency of maritime transport has also reduced the possible number of vessels that can use the Port of Beira, resulting in economic losses for the Port. As a result, emergency dredging of the channel has been recommended to remove the excess sediment and to return the channel to its original width and depth to accommodate ships of 50,000 DWT. It is anticipated that this will increase the economic activity of the Port and region of Beira.

The dredging activities started in August 2010 and are due to end in June 2011. An estimated 5.6 million m^3 of sediment will be removed, comprising fine sands and silts with an average density of 1.8 tonnes / m^3. Sand is being reused to rebuild the harbour wall, while the silty dredged material is being disposed of at a site situated 23 km to the east of Beira Port (see *Figure 8.3*). Annual dredging will be required to remove 2.4 million m^3 to keep the channel open for large vessels.

Port Communication Systems

The Maritime Communication Network aims to ensure effective communications at standards acceptable to the IMO and ITU, for the safety of navigation, search and rescue and for coordinating maritime accidents such as oil spills. The Maritime Communications Network was recently upgraded into a new GMDSS Coastal Radio Station that includes two newly upgraded Radio Stations, one in Inhambane and another at Ilha de Moçambique, as well as the rehabilitation of the Central Maritime Communication Centre in Maputo. These Stations were upgraded to integrate with the ones which were in operation in Beira, Quelimane, Nacala and Pemba.

7.5 SHIPWRECKS

While no reports exist of shipwrecks of archaeological and historical importance in Sofala Bay, it is possible that such remains may occur. Sofala Bay was a key coastal location for the early Portuguese navies trying to establish settlements in the Indian Ocean in the early 1500's as a base for trading in goods and expanding Christian influence over Islam. The Seventh Armada was the largest Portugese armada comprising a number of vessels and men. The patrol assembled to create a base at Sofala under Pero de Anaia and his fleet of six ships landed in Sofala in 1505 and sought permission from the Sheikh Isuf of Sofala to build a fortress, which was granted. At this time there was significant trade with India for spices and silk. A few ships are throught to have gone missing along the Sofala Mozambique coastline during this period. The chances of finding shipwreck remains in Sofala Bay is regarded as low as no shipwrecks were revealed during previous seismic surveys.

Section 4

Impact Description and Assessment

Chapter 8: Environmental and Social Impacts

Chapter 9: Oil Spill Modelling and Impacts

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SECTION 4: CONTENTS

LIST OF TABLES

8 IMPACT DESCRIPTION AND ASSESSMENT:

8.1 INTRODUCTION

The significance of potential environmental and social impacts of the proposed exploration well drilling and well testing activities for the Sofala Concession, are described in this chapter, together with the mitigation measures for impact prevention, mitigation and control. The criteria used to evaluate impacts and assign significance are included in *Chapter 2*.

Offshore exploration well drilling and testing is a well-established practice and the impacts of these operations on the marine environment are broadly known. A number of research studies have been conducted that enhance knowledge of the nature and magnitude of impacts related to offshore drilling and well testing, and relevant studies have been cited throughout the text.

The identification of issues associated with the proposed drilling and well testing activities in the project areas was based on:

- issues raised during the Scoping Phase;
- a review and understanding of the affected environment;
- review and understanding of the nature of the activities, and the findings of relevant published studies; and
- the professional judgment and expertise of the Specialist Team.

The main environmental impacts of exploration well drilling and testing can be divided into two categories; those associated with normal operations and those associated with emergency events (eg oil spill). Each of the impacts associated with the two categories are assessed below.

The evaluation of impacts presented in this report covers well drilling and testing at the provisionally identified sites shown in *Figure 6.1* or at any other site in the concession within 10 km of the shallow or deep water prawn fishery. This distance was determined based on the worst-case scenario of potential turbidity and biochemical impacts on the prawn fishery. Dispersion modelling at the current sites has indicated a potential cuttings settlement zone of 4.76 km^2 (equivalent to a maximum of 1.2 km from the drill site), while turbidity plume modelling for the shallow water environment near Bazaruto predicted elevated turbidity over a 5 km radius from the well site. To allow for potentially higher silt content in the sediments of Sofala Bay (due to the higher silt laden inflows from major rivers: Pungue, Save and Buzi), and for potential noise effects, we have allowed for a 10 km buffer zone from the fishing areas within which turbidity levels are expected to drop to normal ambient levels. If revised drill site positions are identified within this 10km buffer zone additional investigation and discussion with fishing stakeholders will be needed, which will require an addendum to this EIA for approval by MICOA.

8.2 DRILLING RIG POSITIONING AND OPERATIONS

8.2.1 Impact of Positioning the Drilling Rig on the Marine Environment

Impact Description

Four types of drilling vessels or rigs have been considered for drilling the proposed wells (described in Chapter 5) and the preferred option is to use a jack-up drilling rig. Jack-up rigs are used in water depths of 20 m to 100 m. This kind of rig is anticipated to be used for both wells that may be drilled in the Sofala Concession.

The jack-up drilling rig would be towed to the location with its legs up and the barge section floating on the water. Upon arrival at the drilling location, the legs are jacked down onto the seafloor, preloaded to securely drive them into the seabed, and then the legs are jacked further down to lift the barge section to above the water level.

Prior to establishing the jack up rig, a site assessment will be made involving a geotechnical site survey which may include one or more soil borings to assess the sea floor suitability and requirements for the rig establishment.

Impacts of positioning the drilling rig will arise from direct disturbance of the seafloor and from generation of turbidity from the founding preparations and jack-up process.

Impact Assessment

Soil boring prior to rig positioning to check founding conditions for the rig will inevitably cause some physical disturbance to the seabed and water column (turbidity) and cause loss of benthic fauna across an area of approximately 200 m^2. However, given the expected homogeneity of the seabed in the Sofala Bank, the level of anticipated disturbance caused by positioning the jack up rig is expected to be relatively localized and mainly limited to the footprint of the rig. The seafloor in the vicinity of the drill sites is expected to be sandy, with a relatively high degree of silt in the upper sediment layers derived from the high river inflows of the Buzi and Pungue catchment, and generated from the extensive mangroves along the coast.

Turbidity in Sofala Bay is also compounded by naturally high sand transport along the coast into Sofala Bay and annual coastal regression of about 10 m per year close to Beira. This has resulted in a higher level of turbidity in Sofala

Bay than would be expected closer to Bazaruto. As a result of the anticipated higher silt content, seafloor disturbance in Sofala Bay is likely to generate greater turbidity effects in the water column than in sandier substrates elsewhere. The potential impact of higher turbidity is ameliorated by the natural tidal processes operating in Sofala Bay, which exhibits the highest tidal amplitude in the country, averaging 6.4 m near Beira, and which contributes to the generally higher ambient turbidity levels. Prevailing higher turbidity levels has restricted the development of coral reefs and sea grass communities in the Sofala Bay area, where none are known to occur, and the benthic fauna is expected to be naturally adapted and accustomed to high sediment transport and turbidity. As a result, there are no sensitive ecosystems likely to be vulnerable to, or which cannot recover quickly, from the localized effects of positioning a drilling rig.

Tests done on heavy metals and other constituents in the sediments near Beira (in Consultec 2007) shows low levels of toxic substances, and toxicity effects on the water column arising from sediment disturbance is therefore not expected.

Table 8.1 *Impact of Positioning the Drilling Rig on the Marine Environment*

Nature of Impact	**Physical damage to the benthic marine environment from positioning and/or anchoring a drilling rig to the seabed and increased turbidity of the water column**.
Magnitude	**Magnitude: Low** ***Extent*: Site** only as affected area limited to the drilling rig location and immediate area influenced by sediment dispersion (approximately 200 m^2). ***Duration:* Short-term –** the 60 days required to set up and remove the drilling rig at each well. ***Intensity*: Low** as benthic fauna likely to be widely distributed and not unique to the drilling rig location.
Likelihood	**Definite**
Significance	**Minor**
Degree of confidence	High

Mitigation Measures:

- Apart from careful positioning and anchoring of the drill rig, no other mitigation measures are feasible to reduce marine disturbance during the rig establishment (positioning and/or anchoring) phase.

- Seabed will be scanned to determine founding conditions and this would reveal if there are any sensitive habitats or obstacles, so as to avoid any damage to these when the drilling vessel is positioned.

- On completion of drilling, the sea bed will be scanned to ensure no materials, waste or equipment has been left behind.

Table 8.2 Significance: Positioning of Drilling Rig on Marine Environment

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	**MINOR**	**MINOR**
Post-Drilling	**NEGLIGIBLE**	**NEGLIGIBLE**

8.2.2 Impact of Lighting and Flaring on Nocturnal Marine Faunas

Impact Description and Assessment

Drilling is a 24-hour operation and requires the use of strong lighting to illuminate the drilling rig at night, which will continue for a period of 40-45 days. Flaring for well testing may continue for a period of 10-15 days per well.

Turtles, seabirds, fish and cephalopods may be attracted to the operating lights and the flare of the drilling unit during well drilling and testing operations. The strong lights used to illuminate the drilling rig at night or the illumination from the flaring of hydrocarbons may disturb and disorientate pelagic seabirds, and even cause collisions. In addition, fish and squid may be drawn to the lights or to the flare where other fish and seabirds may more easily prey upon them.

Pelagic birds in the area have widespread distributions and are not known to be particularly numerous in the area. Long-line tuna fishing in the deeper water areas is responsible for much larger scale mortality of pelagic migrants, such as albatrosses than the risk posed by a single drilling rig.

Table 8.3 Impact of Lighting and Flaring on Nocturnal Marine Fauna

Nature of Impact	**The strong lights used to illuminate the drilling rig at night or the illumination from flaring of hydrocarbons may disturb or disorientate pelagic seabirds. In addition, fish and cephalopods may be drawn to the lights where fish and seabirds may more easily prey on them**.
Magnitude	**Magnitude: Low** ***Extent***: **Site** only – affected area limited to the drilling rig location and immediate area illuminated (about 100 m distance). ***Duration:*** **Short-term** - duration of the exploration drilling operation – 45 days maximum for drilling each well (90 days in total) and 10-15 days flaring (30 days total) ***Intensity***: **Low** as species numbers attracted to lights would be relatively low and none are threatened.
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:

- Shield the lights to restrict the range of illumination and reduce the number shining directly onto the water, unless needed for technical or safety reasons; and

- Any birds that are injured or disoriented through collision and found on the drilling rig should be put in a dark container (eg cardboard box) in a quiet area with water, and released during daylight. Any ringed or banded birds should be reported to the agency responsible for monitoring them as indicated on the band.

Table 8.4 Significance: Impact of Lighting and Flaring on Nocturnal Marine Fauna

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	**MINOR**	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**	**NEGLIGIBLE**

8.2.3 *Impact of Helicopter and Support Vessel Operations on Marine Fauna*

Impact Description and Assessment

Helicopters and support vessels may have the following impacts on marine fauna:

- Disturbance of bird colonies;
- Disturbance of marine mammals eg whales and dugongs; and
- Increased collision risk with marine mammals, possibly resulting in injury or even mortality.

Helicopters and support vessels will be used on a daily basis to provide support to the drilling rig, with the major route being between Beira and the drilling location.

Helicopters and support vessel activities can cause significant disturbance to coastal and marine fauna if standard precautions are not taken. Disturbance of nesting or roosting birds in coastal areas can lead to increased mortality of the young of these animals as birds may abandon their nests temporarily, thereby exposing the eggs and chicks to predation. Flying low over whales and dugongs, or approaching these animals by vessel at close range, can disturb the mating behaviour of these animals. Whales and dugongs have long lives, produce few young and therefore have low species turnover.

Mortality of these species therefore has a greater consequence on the population than for species with higher turnover rates.

However, while no important breeding colonies of birds have been reported in Sofala Bay, Bazaruto Archipelago (located approximately 60 km from the southern boundary of Sofala Concession) is a very attractive area and is a potential RAMSAR site for its wading birds. It is also a key location for one of the last remaining populations of dugongs, and may be considered a desirable location for flyovers or boat visits by drilling contractors.

Factors that influence the potential risk of disturbance include altitude / distance of the aircraft or vessel from the animals and the prevailing sea conditions. A minimum flying height of 500 m is generally specified for helicopters in transit, and a minimum distance of 350 m for vessels from marine fauna including bird colonies.

Table 8.5 Impact of Helicopters and Support Vessel Operations on Marine Fauna

Nature of Impact	**Noise impact from helicopter operations and disturbance from support vessels and onboard staff may cause disturbance to bird colonies and marine mammals unless restrictions on flying height and vessel distance are not observed**.
Magnitude	**Magnitude: Low** ***Extent*: Regional** – affected area includes Sofala Bay and possibly even Bazaruto Archipelago if detours by helicopters or vessels are made. ***Duration:* Short-term** for the 120-day exploration drilling operation. ***Intensity*: Low** as helicopter disturbance is a transient impact of regular occurrence throughout the drilling phase while vessel disturbance of marine fauna is ameliorated by the extent of general fishing boats activity in Sofala Bay
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:

Helicopters:

- Helicopters must maintain a minimum in-transit flying altitude of 500 m.
- Adhere to direct flight paths between Beira and the drilling rig and do not hover over or circle any marine fauna or sensitive areas with coastal birds.
- All pilots and crew to be aware that deviations to flight paths are not permitted unless for technical or safety reasons.
- Maintain vessels in good working order to reduce noise levels.

Support Vessels:

- Support vessels to maintain a distance of 350 m from marine mammals and to keep look out to avoid collision and to provide prior warning to enable detours at a safe distance.

- All crew and pilots must be briefed to understand the sensitivity of whales and dugong and that detouring to approach such marine fauna is not permitted.

- No hunting or harassment of these species is allowed by on-board staff or other visitors.

Table 8.6 Significance: Impact of Helicopters and Support Vessels on Marine Fauna

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	MINOR	MINOR
Post-Drilling (Residual)	NEGLIGIBLE	NEGLIGIBLE

8.2.4 Impact of Well Drilling Noise on Marine Animals

Impact Description

Drilling ships and platforms produce noise at frequencies of 5Hz to 1.2 kHz and strengths ranging from 119 to 127dB, which when compared to ships that produce noise at 1Hz to 1kHz or up to 200dB, is not dissimilar. However, drilling rigs remain in one position for a period of time, rather than moving in-transit.

The level of noise from the drilling rig will depend on the type of drilling rig that is used. Hurley and Ellis (2004) maintain that sound radiated underwater during drilling operations is highest for drill ships and semi-submersibles, followed by bottom-founded platforms such as jack-ups and drill barges.

Hurley and Ellis (2004) state that drilling noise usually produces prominent tones at frequencies below 300 Hz, with the strongest tones below 5 Hz. Dynamically positioned vessels are noisier than anchored units due to additional noise from thrusters and propellers. Noise levels for drill-ships and semi-submersibles are similar in range to some super-tankers, supply vessels, and fishing trawlers. Noise associated with conventional bottom-founded drilling platforms is relatively unstudied; however, evidence suggests that the sound levels generated are not significant (RAC, 2004).

General Impact of Noise on Marine Biota

The potential effects of noise on marine animals can be categorised as follows:

- Behavioural changes are often hard to detect but generally involve a cessation of normal activities and the commencement of avoidance or startle behaviour as a result of the detection of sound from well drilling activities; continued exposure is likely to result in habituation to the sound by some species, followed by normal behaviour.

- Masking or interference with the use of acoustic communication signals or naturally produced cues used by marine animals.

- Pathological damage could arise from the differential rate of transmission of sound pressure waves through tissues of varying densities. The effect is particularly marked at interfaces between tissues and gas-filled cavities, for example, the swim-bladders of fishes or the lungs of animals. The sound-receiving apparatus of most animals is generally comprised of sensory hair cells, which are extremely sensitive to vibrations, over stimulation of which can potentially lead to permanent damage.

For an organism to respond to sound, the sound has to exceed that of the ambient noise, which has either non-biological or biological origins. McCauley (1994) noted that non-biological underwater noise has three principal sources, namely wind, rain and anthropogenic causes.

The most pervasive anthropogenic noise sources are those produced by ships. Shipping sounds cover a wide range of spectra, and include extremely loud noises when the source is in close proximity. *Table 8.7* summarise the non-biological and biological sources of noise and provides some expected ranges in relation to the drilling operations.

Table 8.7 Comparison of Underwater Noise Types

Source	Frequency and Strength
Wind	1Hz – 25 Hz; 93 dB @ 100-200Hz (Force 12)
Rain	Broad spectrum; 80 dB (heavy rain)
Ships	1Hz – 1kHz; 0-200 dB (depending on range)
Invertebrates	2-10 kHz; <140 dB-m
Fish	100 Hz – 5kHz; 140 dB-m
Mammals	12 Hz – 160 kHz
Drilling (from fixed platform)	5Hz – 1.2 kHz; 119-127dB

Impact Assessment

There is insufficient knowledge on the short or long-term effects of noise on marine mammals, or the distribution and abundance of such species in Sofala Bay. It is therefore only possible in this assessment to extrapolate potential noise effects likely to be generated from drilling on marine fauna known to occur in the area using existing studies that have been done internationally.

Marine mammals are more tolerant of stationary noises, such as drilling, than mobile ones, and this is consistent with the probable response threshold varying with perceived relevance or threat level of the source (Richardson *et al*., 1995). Behavioural reactions of marine mammals to noise from drilling rigs was found to begin at broadband levels of 115 to 120 dB re 1 µPa @ 1 m (cited in Hurley and Ellis, 2004). Few whale species would remain within an area where received levels exceed 140 dB re1µPa. However, several whale species, both feeding and with young, were recorded by observers within the immediate vicinity of a jack-up drilling rig and a drill ship in eastern Canada, suggesting little effect of drilling on whales (Hurley, 2000; Marathon Canada, 2003).

Dugongs are unlikely to be resident in the Sofala Bay area, particularly closer to Beira due to the higher prevailing turbidity and lack of sea grass meadows, and only tend to occur at depths less than 8-15 m (ERM & Consultec, 2008). Therefore no effect of noise on these species is anticipated.

Sea turtles are considered to be less sensitive to noise than marine mammals (Thomson *et al*., 2000), while the threshold for behavioural effects on fish has been measured at a received sound level of 160 dB re 1µPa from a strong stationary noise pulse (Thomson *et al*, 2000). Fish returned to normal behaviour within 20 to 60 minutes after the noise source was removed. According to Turnpenny and Nedwell (1994), egg and larval damage due to noise occurs at 220 dB re 1 µPa, beyond the expected noise generated by drilling.

Underwater noise from drilling activities is not likely to exceed ambient noise levels at a distance greater than 10 km from the source (Greene, 1986, Richardson *et al* 1995). Since the drilling vessel is in a fixed position, any marine animals near the vessel would be initiated by the animals themselves.

Since a jack-up vessel is proposed for use in the Sofala Concession, which are known to be less noisy, and other data indicates that whales and other species can tolerate the expected range of drilling noise (or move away from it), no significant effects of noise on these species is expected. Any noise effect from the drilling rig would be localised, and any loss of habitat due to higher noise would be short-term, limited to the drilling period of 45 days per well.

Table 8.8 Impact of Well Drilling Noise on Marine Animals

Nature of Impact	**Noise impact generated from well drilling could impact on the behaviour and distribution of marine animals**
Magnitude	**Magnitude: Low** ***Extent*: Local**– not likely to exceed ambient noise levels at a distance greater than 10 km from the source. ***Duration:* Short-term** – limited to the duration of the exploration drilling operation (maximum 120 days). ***Intensity*: Low** (noise levels similar to other ships in transit and marine fauna found to occur in the vicinity of drilling rig, and the impact is ameliorated by the fact that many vessels and fishing boats operate and pass through the area)
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:

- Avoid sudden loud noises, such as from the moving and putting down of heavy equipment, when marine mammals are observed to be present.
- Maintain the vessel and all noise generating equipment in good working order.
- Helicopters approaching the drill vessel for landing should ensure that no whales are present and if they are to take steps to detour around them before landing from the other side.

Table 8.9 Significance: Impact of Well Drilling Noise on Marine Fauna

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	**MINOR**	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**	**NEGLIGIBLE**

8.2.5 *Impact of Discharge of Cuttings and Drilling Fluids from Well Drilling on the Marine Environment*

Quantities of Drill Cuttings and Dispersion Influences

The quantity of cuttings and drilling fluids predicted to be discharged during the drilling of a 5,000 m well are shown in *Table 8.10*.

Table 8.10 Expected Drilling Program Discharges for a 5,000 m well

Drill section	Diameter (inches)	Depth (m)	Cutting Vol (m^3)	Mud Vol (bbl)	Drilling Mud Type	Discharge Level
1	36	100	67.57	1,100	WBDF	Seabed
2	26	200	69.95	3,300	WBDF	Surface
3	17.5	700	111.29	2,700	WBDF	Surface
4	12.25	2500	198.73	65	NADF	Surface
5	8.5	1500	57.24	20	NADF	Surface
	Total	**5,000 m**	**504.78 m^3**	**7185 bbl**		

The total volume of cuttings to be discharged from each deep well (drilled to 5,000 m) is expected to be 505 m^3 of which 249 m^3 will come from the 'top hole' (36", 26" and 17.5" sections) and 256 m^3 from the 'bottom hole' (12.25" and below). Cuttings will be released near the sea surface except for that generated during drilling of the top 36" section of the well. Water-Based Drilling Fluids (WBDFs) will be used for the top hole and a Group III Non-Aqueous Drilling Fluids (NADFs) for the bottom hole (see Chapter 4 for more information on the mud programme). It is recommended that the NADFs be recycled through a treatment process on board the drill vessel to reduce oil content on the drill cuttings to <5% hydrocarbon content before being released at least 3-5 m below the sea surface.

The degree of dispersion and fate of drill cuttings is determined by hydrographic conditions (currents and tides) in combination with particle size distribution, type of drilling mud used, chemical weathering, bioturbation, and biological uptake. Flocculation of the particles (ie tendency to clump together) and density gradients in the receiving marine environment may also have an influence on cutting dispersion and biodegradation. WBDF cuttings tend to disperse more readily and to be spread more thinly over a wider area of seabed, while dispersion of NADF cuttings are spread over a smaller seabed footprint.

Drill cuttings can be divided into two fractions:

- coarser material that will sink quite rapidly and have a short residence time in the water column; and

- finer material that will have a longer residence time in the water column, ie remain in suspension and become more widely dispersed.

A modelling study was undertaken in order to determine the likely dispersion and settlement pattern of the drill cuttings.

Dispersion Modelling

Cuttings discharge modelling has been undertaken for the proposed well drilling campaign in Blocks M-10 and Sofala. Applied Science Associates' (ASA) Mudmap was used to perform the dispersion modelling (***Annex E***). Mudmap is a numerical model developed by ASA to predict the near and far field transport, dispersion, and bottom deposition of drill fluid and cuttings. The model takes into account local hydrographical conditions, the volume and nature of discharges and rate of discharge. Discharge modelling incorporated hydrographic conditions during the expected drilling period between March and November.

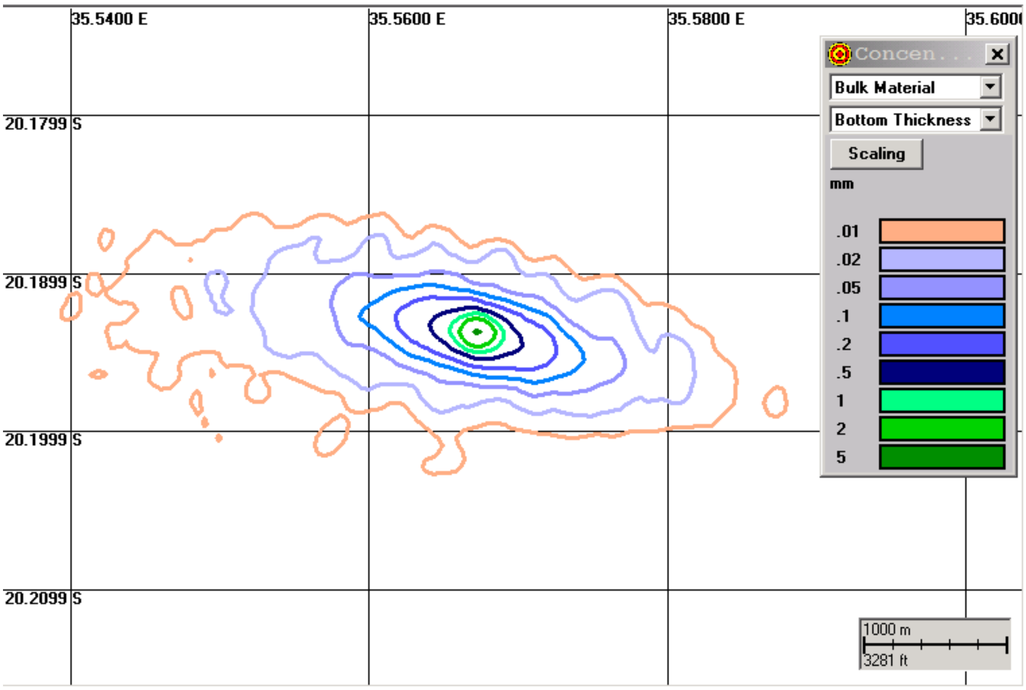
The model predicts the initial fate of discharged solids, from the time of discharge to initial settling on the seabed. The model output consists of simulated accumulation of discharged solids on the seabed.

For the Sofala Concession, modelling was done for discharges from the proposed Charlie site situated on the shelf in water of 30 m depth (see *Figure 4.1*). Discharges of WBDF cuttings as well as NADF cuttings were modelled to assess the difference in dispersion pattern using different fall velocity distributions for the two types. The grain size distribution of drill cuttings used in modelling was based on previous studies in the vicinity of the area of study and previous project experience.

Modelling of predicted discharge deposition indicated that cuttings are the primary component of the deposited materials, with the drilling mud fraction dispersing in the water column and contributing less than 0.1 mm deposition. As the Charlie well is located in shallow waters and far from the shelf break, the major dispersion influences is tidal, rather than larger currents which result in sediments depositing around the well and spread in both an on- and off-shore direction without a clear transport direction. *Figure 8.1* and *Table 8.11* quantifies the areal spread of the different zones of thickness in the depositional area.

Modelling results predict the cuttings deposition would occur across a maximum area of approximately 4.76 km^2, in which the area receiving 1 mm or more of sediment would be limited to a total of 0.077 km^2 equivalent to about a 160 m radius from the drill site.

Figure 8.1 Predicted Total Accumulated Seabed Deposition Thickness from Charlie, Sofala



Source: ASA, 2010

Table 8.11 Summary of Predicted Seabed Deposition due to Drilling Discharges

Thickness (mm)	Sofala – Charlie km²	M-10 Alpha km²
0.01	4.76	6.40
0.02	2.57	3.99
0.05	1.17	1.76
0.1	0.69	1.01
0.2	0.40	0.30
0.5	0.16	0.04
1	0.077	0.022
2	0.035	0.015

Impact Description

The environmental effects of drill cutting discharge and fluids are considered under three headings, namely:

1. *Smothering effects:* The discharge of cuttings and drilling fluid may smother benthic organisms. The smothering effect of cuttings and drilling fluid released during drilling can either directly (from winnowing of disturbed material) or indirectly by smothering as the drill sediment plume settles down. Possible effects of smothering

include burial, clogging of feeding mechanisms, temporarily altering the nature of the seabed sediments and reduction of light for photosynthesis. Typically, high energy (shallower) environments recover rapidly, but some deep-sea benthic communities are sensitive to burial and may require years to recover.

2. *Turbidity effects*: A potential concern is that increased turbidity of the water column may place transient stress on benthic organisms or water column biota (eg plankton) not adapted to dealing with high loads of fines (Muschenheim and Milligan, 1996).

3. *Biochemical effects*: Potential effects of discharged drilling fluid and contaminated cuttings include direct toxicity, organic enrichment and contaminant bioaccumulation. The effects may be of significance in terms of acute or chronic effects on biota.

Impact Assessment

i) Smothering of Benthos and Altered Benthic Habitat

Benthic fauna on the continental platform of Sofala Bay is poorly known and there is no information on the distribution and abundance of benthic species such as polychaete worms, molluscs, and small crustaceans, such as copepods and ostracods. These three types are the most common benthic fauna. Crab and lobster species can also be expected. Offshore benthic habitats of Sofala Bank, which comprise a sandy-muddy substrate, are considered less productive and to have lower species diversity compared to shallower coral reef and sea grass bed habitats.

Prawns, which are an important component of the fishing industry in the area, spend their post-larval adult stages on the seabed and sometimes at different levels in the water column, and the juvenile stages in estuaries. The adults are nocturnal, spending the day buried in the seabed substrate, and feeding on detritus during the night. Prawns can be found throughout the study area but shallow water prawns generally occur in waters from 20-50 m depth, with some up to 90 m depth, while the deep water prawns occur in much deeper water from 200-800 m. Prawns filter-feed on a wide range of marine organisms include zooplankton, phytoplankton, and detritus.

The discharge of cuttings and drilling fluid will smother benthic organisms within the zone of deposition around the well site, and to some degree will alter the benthic habitat structure through altering the grain size composition. Benthos on the continental shelf is generally dominated, in terms of abundance and biomass, by polychaete worms, molluscs and crustaceans, which are predominantly filter-feeders. Studies on the effects of smothering indicate that polychaetes can survive instantaneous smothering to a depth of

30 cm, molluscs by 16 cm and crustaceans were able to burrow through 7 – 30 cm (Maurer *et al* 1980, 1981, 1982 in Lwandle 2008). On average, it can be conservatively assumed that most benthic organisms should survive instantaneous inundation by 5 cm depth of cuttings.

The majority of cuttings discharged are expected to fall into the 250 to 500 microns size range (ie 80 percent sand) with 10 percent falling into the 707 micron category. Finer silts of less than 44 microns are expected to comprise 14 percent of the sediment discharge. Cuttings sizes will vary as the well is drilled deeper through different geological strata.

As the well is drilled the sediments and cuttings accumulate around the well site and are dispersed through tidal and current influences. The model predicts that deposition of cuttings around the well site will be limited to less than 2 mm thickness over most of the depositional area. The total depositional area of cuttings is predicted to be 4.76 km^2 mostly with a deposition thickness of less than 1 mm, extending an average distance of 1.2 km from the drill site. Mounding of cuttings is expected to be limited to the immediate area around the drill site.

The thin depositional thicknesses over most of the settlement zone are not expected to affect benthic fauna to any significant degree as the particle sizes will be similar to the median size for the receiving environment, and habitat modification effects are expected to be localised. Smothering of benthic fauna will be restricted to the immediate vicinity of the well where mounding of cuttings occur from direct discharge to the seabed when drilling the upper part of the well. In any event, benthic and water column fauna tend to recover quickly in high energy environments, in the order of one to three years. In contrast, deep sea benthic fauna can take several years to recover where drilling leads to greater depositional thickness of cuttings due to low current velocity. Populations of crustaceans, reliant on filter feeding, tend to take longer to recover.

Table 8.12 Smothering Impact of Drilling Fluids and Cuttings on Marine Environment

Nature of Impact	**Deposition of drill cuttings in the drilling area can smother benthic fauna on the sea floor causing clogging of gills, and altered habitat structure.**
Magnitude	**Magnitude: Low** ***Extent*: Local –** Immediate vicinity of the well site where mounding of cuttings occurs. *Duration:* **Short-term** – is not likely to extend beyond a six month period as current movement will gradually disperse cuttings and they will be worked into the underlying sediments by burrowing fauna. ***Intensity*: Low** – depositional area is mostly less than 2 mm thickness and benthic fauna are predicted to adapt to cuttings settlement.
Likelihood	**Definite**
Significance	**Minor**

Nature of Impact	**Deposition of drill cuttings in the drilling area can smother benthic fauna on the sea floor causing clogging of gills, and altered habitat structure.**
Degree of confidence	**High**

Mitigation Measures:

- Release cuttings three to five metres below sea surface to aid dispersion while reducing the concentration of cuttings on the seabed.

Table 8.13 Significance: Smothering Impact of Drilling Discharges on Marine Environment

Phase	**Significance**
Drilling	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**

ii) Turbidity Impact

Beyond the immediate vicinity of the drilling site, concentrations of suspended sediments introduced into the environment by the drilling operations are typically less than the naturally-occurring suspended sediments in the water column (Neff *et al*, 1987). The upper water column plumes associated with the disposal of drill cuttings typically contains less than 10 percent of the discharged drilling fluids and between 4 and 10 percent of the total mass of the combined discharged drill cuttings and drilling fluids (Neff *et al*., 1987). The discharged drilling fluids are, however, rapidly diluted, usually within one to three kilometres of the discharge and within a few hours, and quite frequently dilutions of 1000-fold are achieved within a few metres of the discharge (Neff *et al*, 1987).

Cyclones frequently occur in the project area between December and March, and naturally generate high suspended sediment loads in the water column at an order of magnitude greater than that of discharged drilling fluid and cuttings. These cyclone events frequently cause impacts on marine habitats not adapted to dealing with high loads of fines (coral reefs and sea grass beds). Natural Total Suspended Sediment (TSS) levels in waters of the continental shelf are expected to range between 2 – 10 mg/l (Zoutendyk, 1995, and Lwandle, 2008).

The effects of turbidity to marine organisms in the water column will be limited to the dimensions of the sediment plume generated by the discharge and the time taken to disperse and settle. A high percentage (80 percent) of the particle sizes will be larger than 100 microns and will have a rapid fall rate through the water column thereby contributing minimally to water column turbidity. Sediment sizes less than 100 microns, expected to comprise approximately 19 percent of cuttings, will remain suspended for longer but will gradually disperse and settle.

Model results for sediment dispersion indicates that the turbidity plumes associated with the discharge of drill cuttings would be limited to a maximum area of 4.76 km^2 or an average of 1.2 km from the drill site. The turbidity plume associated with shallow water drilling is likely to be fairly extensive due to tidal influences. Based on modelling results for the shallow water environment near Bazaruto, concentrations exceeding 20-50 mg/l were expected within 1-2 km of the site and significantly elevated concentrations within 5 km of the discharge (ERM & Consultec 2008) with limited duration. Similar turbidity effects could be expected in the shallow areas of Sofala Concession. TSS concentrations are likely to disperse and settle and to quickly approximate background turbidity levels in Sofala Bay. Therefore no significant turbidity impacts are expected on the water column biota.

Table 8.14 Turbidity Impact of Drilling Cuttings on Marine Environment

Nature of Impact	**Elevated turbidity caused by drilling and dispersion of the cuttings plume can affect filter feeding plankton and other organisms in the water column.**
Magnitude	**Magnitude: Low** ***Extent*: Local -** turbidity zone would likely be limited to an area of 5-10 km from the drilling site. ***Duration:* Short-term** - turbidity plume is expected to settle within days and is not likely to extend more than a few days beyond the four month drilling period. ***Intensity*: Low** – as ambient turbidity often high in continental shelf waters and therefore biota not likely to be sensitive to periods of increased turbidity.
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:

- The turbidity plume will be mitigated by maintaining the point of discharge approximately three to five metres below the sea surface level.

Table 8.15 Significance: Turbidity Impact of Drilling Discharges on Marine Environment

Phase	**Significance**
Drilling	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**

iii) Biochemical Impacts

A combination of a WBDFs and a Group III NADFs will be used for drilling. A NADF is required for the lower sections of the well to ensure better well stability (for drilling through water sensitive shales) and to provide improved drilling efficiency, and therefore lower operational and environmental risks. NADFs also offer better lubricity and high temperature stability, and reduce the formation of gas hydrates – a particular issue for deep water wells.

Group III NADFs have low to negligible aromatic content and were developed to address environmental issues related to overboard discharge as they are more readily biodegradable, and less toxic and less hazardous to drill crews than other NADFs. Concentrations of polyaromatic hydrocarbons (PAH) in Group III NADFs are less than 0.001 percent compared to 0.35 percent in Group II NADF, and 5-10 percent in Group I NADF. WBDFs, containing bentonite with some barite (barium sulphate), will be discharged with the cuttings at the seafloor. It has not yet been confirmed whether the Group III NADF will be an enhanced mineral oil based fluid (EMOBF) or a synthetic NADF.

EMOBF have poorer environmental performance and therefore this assessment assumes that a product in this range could be used as the worst case scenario. EMOBFs have been shown to bio-accumulate in marine species, such as molluscs, crustaceans and fish with the main concern that the toxic effects of NADFs biomagnify up the food chain. However, mineral oils with low levels of aromatics, such as Group III NADFs, indicate that while bioaccumulation occurs, the elimination rate is high with negligible levels of biomagnification through the food chain. The time required for the breakdown of the organic component of the NADF and for reoxygenation of the sediment and recolonisation by benthic species will vary depending on the tides and currents, thickness of the sediment, water temperature and sensitivity of the species present. Minimising oil content on cuttings to 5 percent by treating and drying, increases dispersion of cuttings and reduces toxic effects in more localised area. In high energy areas recovery can be expected within one year, but in deeper water low energy systems, recovery can take three to five years for NADFs to degrade to low concentrations (Neff *et al*, 2000; CSA, 2004). Areas where Group I fluids were used can take more than ten years to recover.

The toxicity effects arising from the use of NADFs on benthic fauna and the water column are likely to be limited as this arises through hydrocarbons attached to sediment particles in the cuttings discharge. Since low suspended sediment concentrations are anticipated as a result of rapid settling out of most of the cuttings within a relatively small area, this would result in low hydrocarbon concentrations in the water column. The fraction of hydrocarbons that attach to settled particles in the 6.4 km^2 depositional area are expected to be relatively rapidly biodegraded through the action of bacteria in the muddy sediments. Any toxic effects on benthic fauna that might occur through bioaccumulation or deoxygenation of the upper sediment layer can be expected to recover within one year and to be of low intensity given the high benthic biomass that can recolonise from adjacent areas. No sensitive habitats such as corals and sea grass are located within the sediment depositional area.

Table 8.16 Biochemical impact of Drilling Fluids and Cuttings on Marine Environment

Nature of Impact	**Presence of drilling mud hydrocarbons in the water column and falling to the seabed with cuttings can result in localised deoxygenation and bioaccumulation of toxins in marine fauna.**
Magnitude	**Magnitude: Low** ***Extent*: Local –** limited to the turbidity plume extending approximately 5-10 km from the drilling site and sediment dispersion area extending over 4.76 km^2. ***Duration:* Medium-term** – sediment dispersion area can be expected to recover within one to three years through biodegradation and recolonisation of sea floor by species from adjacent areas. Water column impacts would be short-term. ***Intensity*: Low** – depositional area less than 2 mm thickness and high potential for biodegradation of hydrocarbons and recolonisation. No sensitive habitats present.
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:

- Use a low toxicity Group III NADF, preferably a synthetic based mud over an enhanced mineral oil based fluid (EMOBF).
- Use advanced cuttings treatment technology to treat and dry drill cuttings to reduce oil content to five percent weighted average.

Table 8.17 Significance: Biochemical Impact of Drilling Discharges on Marine Environment

Phase	Significance with embedded mitigation
Drilling	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**

* assumes use of Group III NADF low toxicity drilling fluid

8.2.6 Impacts of Discharges and Emissions on the Marine Environment

Impact of Air Emissions

Diesel would be used aboard the drilling rig and supply vessels as fuel for generators and motors during well drilling and testing activities. Diesel exhaust comprises SO_2, CO and CO_2, and NO_x, plus "carbon-black" (soot) that contain some polyaromatic hydrocarbon particulates. There is some concern that soot is carcinogenic. Flaring emissions comprise predominantly CO_2 emissions, although sometimes includes SO_2 but this would depend largely on the sulphur content of the gas.

These compounds are known to contribute to atmospheric impacts such as the greenhouse effect through ozone depletion.

The contribution of these air emissions to local air quality will be very small, and with the drilling rig located over 40-50 km from shore such emissions would not be noticed by residents of Sofala Province. Since a 500 m exclusion zone would be maintained around the drilling rig no other sea users would be affected by the emissions.

Table 8.18 Impact of Air Emissions

Nature of Impact	**Diesel exhaust gases and release of unburned hydrocarbons from well testing and associated flaring can impact on air quality.**
Magnitude	**Magnitude: Low** *Extent*: **Local**– not likely to exceed immediate area around the drill vessel (within exclusion zone). ***Duration:*** **Short-term** - for the duration of the exploration drilling and well testing activities (approximately 120 days). ***Intensity***: **Low** – relatively minor quantities of exhaust gases will be generated.
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**Medium**

Mitigation Measures:

- Regular maintenance of motors and generators to ensure exhaust gases contain the minimum soot content.
- Flare burners must operate efficiently, and be maintained and effectively controlled.

Table 8.19 Significance: Impact of Air Emissions on Marine Environment

Phase	**Significance with embedded mitigation**	**Significance with additional mitigation**
Drilling	**MINOR**	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**	**NEGLIGIBLE**

Impact of Deck Drainage, and Release of Machinery Space and Ballast Water

Water washing off the deck areas of the drilling rig could contain small amounts of oils, solvents, cleaners, drilling fluid additives and other similar products which could be toxic to marine organisms. Any spillages of diesel, cleaning solvents or fluid drilling chemicals aboard the drilling rig or on the supply vessels could end up in the sea.

Small quantities of hydrocarbons, such as diesel fuel from engines, lubricants, grease etc used onboard the drilling rig have the potential to enter the marine environment. When oil enters the marine environment there is a transformation of the molecular structure and composition, mediated by microbial and photochemical processes. This forms substances that are potentially harmful to marine fauna. Certain fractions of oil can be metabolized and biodegraded rapidly, while other fractions are relatively persistent.

Release of oily water from machinery areas and ballast tanks must comply with MARPOL standards. The impact of minor amounts of oily water released to the environment will be limited to the immediate vicinity of the drilling rig, and the prevailing oceanographic conditions in the area would ensure rapid dispersion and oxidation of any residual oil in the discharged water.

Table 8.20 Impact of Deck Drainage and Machinery and Ballast Water on the Marine Environment

Nature of Impact	**Water washing off deck areas of the drilling rig could contain small amounts of oils, solvents, cleaners, drilling fluid additives and other similar products which could be toxic to marine organism**
Magnitude	**Magnitude: Low** ***Extent*: Local**– not likely to extend beyond immediate area around the drill vessel (within exclusion zone) *Duration:* **Short-term** - for the duration of the exploration drilling and well testing activities (approximately 120 days). *Intensity*: **Low** - polluted water is expected to disperse rapidly by currents
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:

- Treatment and discharge to be undertaken in accordance with MARPOL standards;
  - Oil from machinery space drainage <15mg/l
  - Oil from other effluents <40mg/l (monthly average)
  - Oil from other effluents <100mg/l (instantaneous limit).

- Suitable containment measures and adsorbents to deal with spills to be provided on the drilling rig.

- Staff to be suitably trained to deal with spills and discharges.

- Low toxicity biodegradable detergents should be used in preference to more toxic options.

- Regular monitoring of drainage discharge for oil content to be analysed to ensure compliance with standards, and in accordance with a Monitoring Plan.

- Recording of spills and irregular discharges as incidents, in accordance with required incident report procedures.

Table 8.21 Significance: Impact of Deck Drainage and Machinery Ballast Water on Marine Environment

Phase	**Significance with embedded mitigation**	**Significance with additional mitigation**
Drilling	**MINOR**	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**	**NEGLIGIBLE**

Sewage and Galley (Kitchen) Waste

Untreated sewage increases the organic and bacterial load on the natural biodegradation processes of the sea. Many marine micro-organisms such as bacteria metabolize sewage resulting in rapid biodegradation. The availability of raw sewage as a food source can lead to a rise in bacterial levels in the water and an increased demand for oxygen. Treated sewage also creates an increased biological oxygen demand (BOD) but no additional bacterial load if it is disinfected. In accordance with MARPOL requirements, sewage can be discharged to the sea if a vessel is beyond 12 nautical miles of shore, and in most cases it is treated and disinfected in an approved treatment plant.

Kitchen waste comprises biodegradable food waste which can pose an organic and bacterial load on the sea. Kitchen discharges include food scraps which will be macerated to less than 25 mm particle size and discharged offshore (beyond 12 nautical miles).

Due to the low intensity of the impact of discharging biodegradable kitchen and sewage wastes, it is expected to be of negligible significance if MARPOL requirements and standards are implemented.

Table 8.22 Impact of Sewage and Galley Waste Discharges

Nature of Impact	**Sewage and food waste discharges to sea can increase the organic and bacterial load but is rapidly biodegraded and dispersed by natural processes.**
Magnitude	**Magnitude – Low** *Extent*: **Local–** not likely to extend beyond immediate area around the drill vessel (within exclusion zone) ***Duration:*** **Short-term** - - for the duration of the exploration drilling and well testing activities (approximately 120 days). ***Intensity***: **Low** as sewage and food wastes are biodegradable and will be quickly degraded by natural processes and dispersed rapidly by currents.
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:

- Comply with MARPOL standards:
  - Macerate food waste to <25mm and discharge beyond three nautical miles of shore.
  - Macerate sewage and discharge beyond 12 nautical miles.

Table 8.23 Significance: Impact of Sewage and Kitchen Waste on Marine Environment

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	**MINOR**	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**	**NEGLIGIBLE**

Garbage and Solid Waste

Solid wastes that may be generated onboard the drilling rig include packaging materials, paper, plastic, tins, glass, as well as hazardous waste such as medical waste (eg bandages, used syringes and blades), and potentially contaminated materials, including oily rags and paint pots, amongst others.

Disposal of general solid waste at sea poses a hazard to seabirds and other marine life through accidental ingestion or ensnaring, and if it contains chemical toxins it can cause poisoning. It also constitutes a visual pollutant as flotsam, either at sea or when it ends up on the shore or the seabed.

MARPOL standards prohibit the disposal to sea of all plastics, polystyrene, and incinerator ash.

Table 8.24 Impact of Garbage and Solid Waste on the Marine Environment

Nature of Impact	**Disposal of general solid to sea can pose a hazard to marine life and pollute beaches. However, adherence to MARPOL standards will eliminate or severely reduce this risk.**
Magnitude	**Magnitude – Low** *Extent*: **Local–** if isolated instances of garbage ends up in the sea ***Duration:*** **Short-term** - limited to possible intermittent and accidental release during drilling operations over the estimated 120-day period. ***Intensity***: **Low** as limited solid waste likely to be disposed of to sea where it can affect fauna.
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:

- Comply with MARPOL standards. No plastic to be disposed to sea.
- Plastic, scrap metal and other non-combustibles should be segregated and recycled where possible.
- Residual solid waste and rubbish generated on the drilling and support vessels (including incinerator ash) should be segregated, weighed and documented in waste manifests prior to disposal at appropriate facilities onshore.
- All hazardous waste (eg medical waste, fluorescent tubes, batteries, oily rags and spent fuel etc) will be collected and retained onboard for disposal at suitable onshore reception facilities.

Table 8.25 Significance: Impact of Garbage and Solid Waste on Marine Environment

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	**MINOR**	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**	**NEGLIGIBLE**

8.2.7 Impacts on Tourism due to Visual Impact and Perceived Changes to the Sense of Place

Impact Description

Tourism in Sofala Bay is very limited and most tourism in the area is located either at Bazaruto National Park, situated at least 80 km to the south of potential drilling areas in Sofala Concession, and approximately 125 km from the proposed site, Charlie. Here, recreational activities include snorkeling around coral reefs and fishing from boats. Very little boat-based recreational fishing takes place in or close to the Sofala Concession. Tourism within Sofala Bay is restricted by the poor infrastructural development in the area (eg roads and accommodation), but also because the marine recreational activities are limited by the poor sea visibility due to high organic content and silt, and the high tidal influence operating in the area, which at low tide leaves the sea far from shore.

Impact Assessment

A drilling rig in Sofala Bay will not be visible from any of the up-market lodges and resorts in Bazaruto, or, if it is even visible, it would not be obtrusive to any tourists along the coast north of Beira. At night the lights on the drilling rig and flaring of gases during well testing would increase its visibility but the closest land to the drilling rig at Delta is 23 km away and therefore out of clearly visible range of sight.

Noise from increased helicopter traffic (estimated at one return flight per day on average) will not affect tourist activities as the main flight path will be between Beira and the drilling rig, rather than southwards where the tourism area of Bazaruto lies. Any coastal tourism around Beira will already be used to regular flights to Beira airport and shipping traffic, and therefore the additional traffic generated by drilling will not significantly increase this load.

However, despite the high profile of Bazaruto internationally, regionally and locally, the presence of a single drilling rig more than 80 km from Bazaruto and the coastline will not have an impact on tourism. While the oil and gas industry is often seen as being in conflict with tourism, and there will be negative perceptions towards drilling, it is not likely to influence numbers of tourists visiting Bazaruto or have a significant impact on visitor perceptions given the desirability of Bazaruto as a destination.

Table 8.26 Impact on Tourism due to Visual Impact and Changes to the Sense of Place

Nature of Impact	**The presence of a drilling rig and additional noise from helicopter and vessel operations may have a visual impact on tourism and drilling activities could result in negative perceptions and reduced tourism to the Bazaruto Archipelago, which is internationally recognised as a prime natural tourist destination**
Magnitude	**Magnitude - Negligible** *Extent*: **Regional** as visual impacts would be of regional extent in Sofala area. ***Duration:*** **Short-term** – limited to maximum 120 day drilling period. ***Intensity***: **Negligible** as drilling rig will not be noticeable >80 km from Bazaruto Archipelago and little tourism exists along the coast north of Beira, a distance of a minimum of 23 km..
Likelihood	**Unlikely**
Significance	**Minor**

Nature of Impact	The presence of a drilling rig and additional noise from helicopter and vessel operations may have a visual impact on tourism and drilling activities could result in negative perceptions and reduced tourism to the Bazaruto Archipelago, which is internationally recognised as a prime natural tourist destination
Degree of confidence	High

Mitigation Measures:

- Sasol must continue efforts to keep stakeholders informed of drilling activities in an open and transparent manner.

- Any changes to the drilling project activities, either locations or timing etc must be communicated to stakeholders to improve trust between tourism and the oil and gas industry.

Table 8.27 Significance: Visual Impact and Perceived Loss of Sense of Place on Tourism Industry

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	NEGLIGIBLE	NEGLIGIBLE
Post-Drilling (Residual)	NEGLIGIBLE	NEGLIGIBLE

8.2.8 *Impact of Drilling on Artisanal and Industrial Fishing*

Impact Description

Impacts on fisheries may arise from the following effects:

- Maintenance of an exclusion zone around the drilling rig of 500 m radius, resulting in a total exclusion zone of 0.8 km^2.

- A plume of turbidity with elevated levels of hydrocarbons and barium will be generated from the drilled well and from disposal of drill cuttings into the water column, and will extend over a maximum area of approximately 5-10 km^2. Fish and prawns could be expected to move away from this zone of increased turbidity during the 45-day drilling phase for each well.

- Direct mortality of prawns and possibly some fish caused by drilling rig establishment and onset of drilling through direct contact, loss of habitat and noise and vibrational disturbance. This would be limited to the start up phase only as after drilling has commenced fish and prawns would be expected to avoid the drilling site, turbidity plume or main cuttings settlement area around the drilling rig.

The turbidity plume extending up to 5-10 km of the drill site would have an increase in suspended solids and possible oxygen demand from the hydrocarbon content of the cuttings. The volume of water affected by the descending cuttings will depend on various factors such as the volumes discharged, concentration of hydrocarbons on cuttings, and how effectively they were removed before sediment release (which influences cohesiveness and particle size distribution); water "wet-ability" of the cuttings and drilling mud (hydrophobic or hydrophilic properties); mixing at the point of discharge and prevailing currents at the time of dispersion.

Based on the drill cutting modeling undertaken for this study (*Annex E*), the cuttings settlement zone would extend across a total area of approximately 4.76 km^2 and cuttings discharge would generate a plume of higher turbidity with the majority predicted to be concentrated within 1-2 km of the drilling rig but possibly extending and dispersing over 5-10 km. Elevated hydrocarbon and barium content may persist in the cuttings on the sea floor which, in areas where the cuttings settle and are 1-2 mm thick, is predicted to be limited to approximately 160 m of the well site (or a total area of 0.077 km^2). Due to the relatively shallow water depths and dynamic seabed conditions subject to tidal influence, the zone of depositional impact would be expected to recover within one to three years as the residues of NADF cuttings are diluted and dispersed.

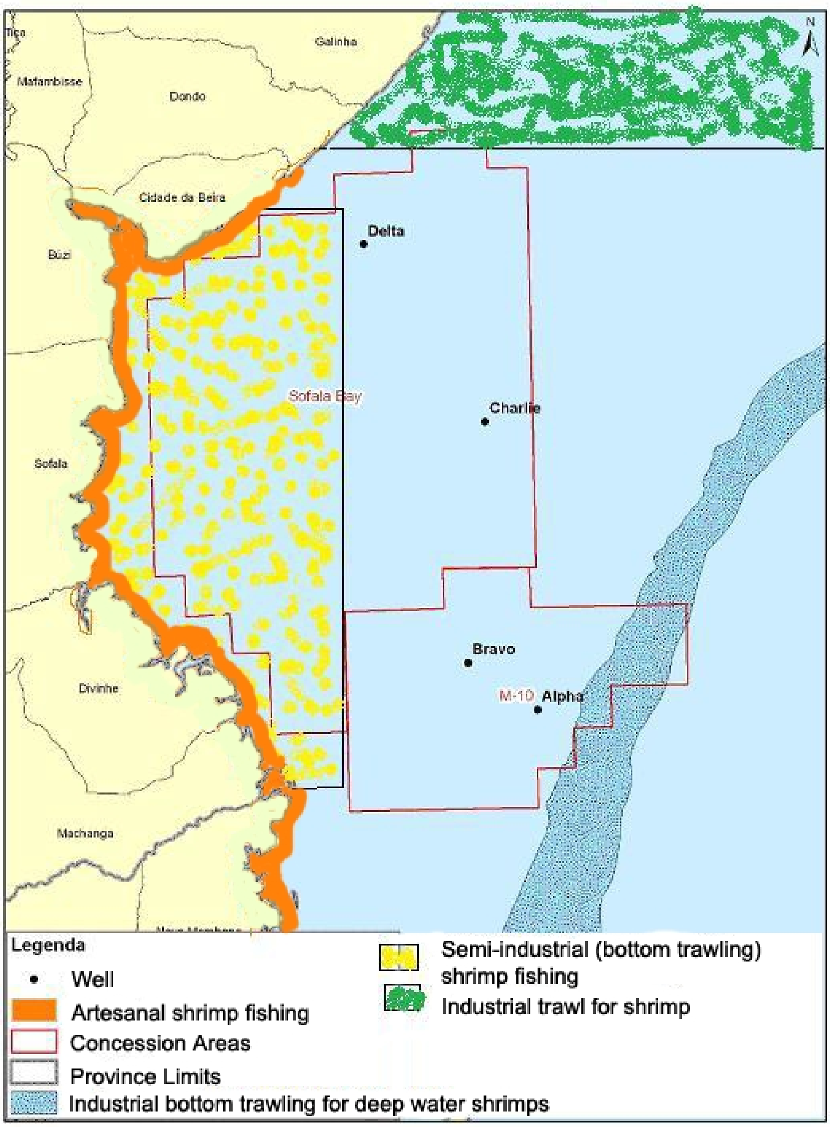
The fishery of Mozambique is the second largest export earner after aluminum with the fishery in Sofala Bank generating 70 percent of export earnings, mainly through the shrimp fishery. Around 50 percent of the six to nine month prawn fishery takes place from March to May. The fishery can be split into artisanal, semi-industrial and industrial fishing.

Artisanal fishing is primarily an inshore activity, extending three nautical miles from shore and involving approximately 4,000 artisanal fishermen and 3,918 vessels offshore of the two districts closest to the project area (Machanga and Govuro) (IIP, 2009). Penaeid prawns that dominate the inshore prawn fishery rely on a life-cycle that involves spawning at sea, migration and growth of juveniles in estuaries and mangrove habitat (nursery areas), and migration of post larvae and maturation at sea in depths up to the 50 m and even 90 m depth zone. Some are nocturnal and spend the day in the sea floor sediments, and feed by night in the water column or sea floor on detritus and plankton. The Save River estuary to the south is an important nursery area for prawns.

The semi-industrial fishery in the southern Sofala Bank in 2009 involved 35 semi-industrial trawlers and 24 larger artisanal vessels of about nine metres, which caught approximately 120 tonnes of the prawn catch. This fishery also involved an additional 27 line fish vessels, catching 734 tonnes of fish. The semi-industrial fishing zone extends from Savane in Dondo District to the Save River mouth and extends offshore to a straight line boundary in approximately 30 m depth zone, and cutting the Sofala Concession in half (*Figure 8.2*). The proposed drilling sites (Delta and Charlie) are outside of this zone, located in deeper water of 50 m and 100 m. However, Sasol may wish to shift the drilling site/s based on further seismic analysis. This EIA has been based on dispersion modeling from the two identified sites and based on this information the impact assessment applies to drilling in the Sofala Concession at a minimum distance of 10 km from the shallow water prawn fishing area. If sites are identified within this 10 km buffer zone or inside the shallow water prawn fishing area then additional investigations and stakeholder consultation will be required to confirm the nature and extent of impacts on fishing.

The industrial fishery involves a significantly greater number of vessels: 58 for shrimp, 16 for deepwater shrimp, 18 for line fish and 155 for tuna. These vessels caught 4,994 tons of shrimp, 1163 tons of deep water shrimp, 83 tons of line fish and 3087 tons of tuna in the Sofala Bank. The major industrial fishing zone lies to the north of the Sofala Concession, while the deep sea pelagic fishery occurs in depths of 200-800 m at least 30 km east of the Sofala Concession.

Figure 8.2 Location of Semi-industrial and Industrial Fishing Activities in Relation to the M-10 and Sofala Concessions



Impact Assessment

Although half the Sofala Concession overlaps with the shallow water prawn fishing area, the two proposed drilling sites in the Sofala Concession are located outside of the prime artisanal and semi-industrial fishing areas in Sofala Bay. Maintenance of the 500 m radius exclusion zone will have a negligible effect on fishing as no trawling or other fishing takes place in the areas proposed for drilling and no fishing activities will be affected. However the Delta site is located in the corridor between Beira and the industrial bottom trawling area to the north of the Sofala Concession, and drilling at this site may require fishing vessels to detour around the rig's exclusion area.

The plume of high turbidity generated by drilling is not predicted to extend beyond a distance of approximately 5-10 km of the well site at levels that could pose a significant risk to water column biota.

Impacts of drilling on the inshore prawn fishery are unlikely or will be minimal as the seaward boundary of the inshore prawn fishery is located at the predicted edge of where the outer limits of the dispersion plume from drilling at Delta may reach, approximately 8 km away. The Charlie well site is located roughly 30 km away and would not affect fishing.

Drilling is also expected to take place outside of the key post-larvae prawn migration phase which occurs between November and March and which coincides with the current (2010/2011) two month closed prawn fishing season in January/February for the small-scale artisanal fishery. Some adult prawns may be present and spawning in the zone of influence of the turbidity column during the drilling phase but the area that would be affected is localized to a distance of 5-10 km of the drill site. The impact of drilling on the prawn fishery, if there is any effect at all, is therefore expected to be very limited and of little consequence provided that drilling takes place outside 10 km of the shallow water prawn fishery.

Table 8.28 *Impacts on Artisanal and Industrial Fishing*

Nature of Impact	**Drilling will require a 500 m exclusion zone around each well site (0.8 km^2) in which no fishing will be allowed, and will generate a plume of turbidity with some elevated hydrocarbon content, and noise, that may cause fish to move away from the zone of influence.**
Magnitude	**Magnitude: Low** *Extent*: **Local** as turbidity plume of cuttings and trace oils extend up to at least 5-10 km from the drilling site within which deposition will occur. ***Duration:*** **Short-term** as drilling expected to last for 120 days. ***Intensity***: **Low** as sediment plume and levels of toxicity would be rapidly dispersed and biodegraded given the tidal influence in Sofala Bay.
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:

- Additional investigations and discussions with MICOA and stakeholders will be required should a drilling site be identified in or within a 10 km buffer zone of the shallow water prawn fishing areas or the industrial shrimp fishing area to the north.

- Ensure efficient and effective oil removal treatment and drying of cuttings drilled with Non-Aqueous Drilling Fluids (NADFs) to less than five percent oil content.

- Discharge drill cuttings treated on the drilling rig three to five metres below the surface.

- Keep all fishing stakeholders (eg representatives of fishing communities and government agencies) informed of the onset and completion of drilling activities.

Table 8.29 Significance: Impact of Drilling on Artisanal and Industrial Fishing

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	**MINOR**	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**	**NEGLIGIBLE**

8.2.9 Impacts on Navigation

Impact Description

The presence of the drilling rig and daily movements of support vessels may cause disturbance by interfering with the movement of other marine vessels.

Annually, approximately 1,000 cargo and fishing vessels pass through the project area at a distance of 20 to 35 miles from the coast. The vessels travelling between Maputo, Inhambane and Beira sometimes travel closer to the coast (20 miles) and pass through the concession areas. A total of 158 vessels of national and regional cabotage made use of the Port of Beira in 2009. This number is however likely to increase after dredging to improve access is completed in 2011, and economic growth and trade expansion into neighbouring countries increases. The drilling rig position may therefore coincide with both shipping transport and fishing vessel movements.

No vessels will be allowed within the 500 m statutory exclusion zone around the drilling rig. Two support vessels, equipped with manned radar, marine radios and lookouts, will be on duty to warn vessels that may come close to the exclusion zone, one of which will travel between Beira and the drilling rig for supplies. In addition, broadcasts will be made on appropriate shipping channels to alert other sea users to the drilling rig location. Notice to Mariners will also be sent out to notify other vessels of the drilling location, exclusion zone, and the anchors (if used). In addition, the drilling rig will be well illuminated at night and will have radar, multi-frequency radio, and foghorns, and will be in constant contact with the support vessel to minimise the risk of collisions. These standard navigational precautions are designed to be effective to avoid navigational hazards posed by the drilling rig and support vessels.

As discussed in *Section 8.2.8* the main fishing zones occur outside of the proposed drilling area of the Sofala Concession. If drilling is to take place at Delta, the drilling rig would be located in the corridor between the main industrial shrimp fishing grounds to the north, and the Port of Beira, and therefore the exclusion zone may require fishing vessels to detour around the rig area, but this is not likely to be a significant issue as all maritime controls will be taken to avoid potential interactions.

Table 8.30 *Impacts on Navigation*

Nature of Impact	**The presence of the drilling rig may cause disturbance by interfering with the movement of other marine vessels, creating a nuisance.**
Magnitude	**Magnitude – Low** *Extent*: **Regional** (possible interference within Sofala Bay due to movement of support vessels and detouring of vessels around a 500 m exclusion zone) ***Duration:*** **Short-term** (120 day drilling phase). ***Intensity***: **Low** (vessels travelling to and from Beira will pass through the Concession and have to detour around the exclusion zone)
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:

- Ensure notification of all fishing and shipping industry representatives of the drill site location prior to drilling.
- Implement all marine navigational measures eg Notice to Mariners, radio communications etc.
- Ensure all navigational and communication equipment is maintained in good working order; and a supply vessel and a look out on the bridge of the drilling rig is on duty at all times.

Table 8.31 *Significance: Impact on Navigation*

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	**MINOR**	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**	**NEGLIGIBLE**

8.2.10 *Impact of Positioning Drilling Rig and Drilling on Shipwrecks / Maritime Archaeology*

Impact Description and Assessment

Although the number and location of sunken ships in Sofala Bay is not known, there are many historical records of shipwrecks covering ten centuries of Arabic dhows, Portuguese caravels (mainly from the 1500's), and launches from the first and second world wars along the Mozambican coast. Sofala was a major centre of activity in the Portuguese armadas in the 1500's.

The proposed drilling project will damage the seabed where the drilling rig is positioned and/or anchored, and at the drilling sites, both through drilling itself and smothering of adjacent areas by drill cuttings. If shipwrecks or other maritime archaeological remains occur, there is the potential for damage to these. On the other hand, there is also the potential for side-scan surveys of the seabed to discover shipwrecks and thereby contribute to maritime archaeological research.

Table 8.32 Impacts of Drilling rig Positioning and Drilling Activities on Shipwrecks

Nature of Impact	**Positioning and Drilling could cause physical disturbance to a possible shipwreck that might occur. [Seabed surveys using side-scan sonar can further maritime archaeological research if shipwreck remains found]**
Magnitude	**Magnitude - Low** *Extent*: **Site** as if it arises it would be a very localised impact. ***Duration:*** **Permanent** as damage to shipwrecks could be permanent. ***Intensity***: **Low** (side-scan sonar surveys would indicate the presence of a shipwreck before rig positioning and drilling takes place
Likelihood	**Unlikely** (chance of finding a shipwreck at the drilling site is very remote)
Significance	**Minor**
Degree of confidence	**Moderate** (likelihood of a shipwreck at the selected drill site is very low but is possible)

Mitigation Measures:

- Seabed surveys using side-scan sonar technology will be undertaken at the selected well sites prior to rig positioning to determine the founding conditions and requirements for the rig. These survey results will be able to detect if any unusual shipwreck remains are present.

- Should side-scan sonar images indicate the presence of unusual maritime archaeological remains, such as a shipwreck, the Maritime Authority (INAMAR) within the Ministry of Transport and Communications should be notified and all drilling activities suspended until such time as the matter has been further investigated and approval given to continue.

Table 8.33 Significance: Impact of Positioning Drilling Rig and Drilling on Shipwrecks

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	**MINOR**	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**	**NEGLIGIBLE**

8.2.11 Impacts of abandoned or suspended wellheads on the fishing industry

If the drilled wells are found to have productive reserves of hydrocarbons they will be suspended for future development. If they are found to be non-viable the wells will be abandoned.

Well suspension involves leaving subsea equipment on the sea floor to a height of approximately five metres above the seafloor. This could have a negative impact on fishing activities if bottom trawling takes place, where nets could become tangled by such obstructions. However, the well site locations are not situated in trawl fishing grounds and are not likely to be regarded as a threat to this type of fishing activity.

Well abandonment involves completing the well with cement plugs and removing all wellhead equipment from the seafloor, and severing the steel casing below the mud line to ensure that no protrusion remains. This situation does not pose any threat to fishing.

Table 8.34 Impacts of Abandoned or Suspended Wellheads on the Fishing Industry

Nature of Impact	**Suspended wellheads could impact on fishing activities where bottom trawling takes place and nets could get entangled by such obstructions. Abandoned wellheads, plugged and severed below the seabed, is not expected to have any impact on the fishing industry.**
Magnitude	**Magnitude – Low** *Extent*: **Site** as would be limited to a 500m radius around the well head. ***Duration:*** **Long-term** (depending on time take to abandon the well). ***Intensity***: **Low** (if no bottom trawling takes place, as appears to be the case)
Likelihood	**Unlikely** as no trawling known to take place in vicinity of proposed wells.
Significance	**Minor**
Degree of confidence	**Low** (no trawl fishing takes place in the vicinity of the drill sites)

Mitigation Measures:

- Casings of suspended wells should be cut below the mud line, preferably to a depth of 3 m, to allow for natural sea floor movement to prevent the casing becoming an obstacle to trawling in future. If technical reasons preclude this possibility, approval should be obtained from MICOA for deviations to this cut off depth.

- If well sites are suspended for future production their locations must be marked on Notices to Mariners and all navigational charts; and
- Inform fishing industry stakeholders of the location of the suspended wells.

Table 8.35 Significance: Impact of Suspended Wellheads on Fishing Industry

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	**MINOR**	**MINOR**
Post-Drilling (Residual)	**MINOR**	**MINOR**

8.2.12 Impact on Health and Social Cohesion

Drilling rigs are staffed with a highly trained and specialised crew, and for this project may number 80-100 drilling and maintenance staff. The crew will work on a rotational basis, with a certain portion being accommodated in Beira or going home during leave time. Crew rotations will be done by helicopter.

The presence of foreign workers poses a risk of impacts on social cohesion and transfer of communicable diseases eg HIV/AIDS and STDs. This is largely due to the fact that expatriate workers, generally male, with relatively large amounts of money and in the absence of long-term wife or partners, engage the services of prostitutes or other willing sexual partners for short-term relationships. Such behaviour can result in an increase in STDs, HIV/AIDS and can impact on a community's social cohesion, particularly where foreign workers are introduced to an established , socially homogenous and cohesive community. However, Beira is a relatively large and diverse city and trading port where foreign workers are frequent visitors. An increase in foreign workers for the short-term drilling project will have little effect on health and social cohesion in and around Beira.

Table 8.36 Impacts of Increased Foreign Workers on Health and Social Cohesion

Nature of Impact	An increase in foreign workers with money when introduced into a homogenous and cohesive community can increase health risks and loss of social cohesion in the receiving community
Magnitude	**Magnitude – Low** *Extent*: **Local** – limited to Beira environs where workers would be accommodated. ***Duration:*** **Short-term** (limited to duration of drilling phase). ***Intensity***: **Low** (as Beira used to through-flow of mobile foreign workers and stays by the majority of drilling staff will be limited to a few days at a time)
Likelihood	**Likely**

Nature of Impact	An increase in foreign workers with money when introduced into a homogenous and cohesive community can increase health risks and loss of social cohesion in the receiving community
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:
All staff should be educated on sexually appropriate behaviour and other social conduct, and the risk and means of transmission of HIV/AIDS, and STDs. Condoms should be readily available to all staff.

Table 8.37 *Significance: Impacts of Increased Foreign Workers on Health and Social Cohesion*

Phase	Significance with embedded mitigation	Significance with additional mitigation
Drilling	**MINOR**	**MINOR**
Post-Drilling (Residual)	**NEGLIGIBLE**	**NEGLIGIBLE**

8.2.13 *Increased Revenue and Economic Benefits Due to Presence of Crew in Beira and Purchase of Local Goods and Services*

The presence of a drilling workforce in Beira on a rotational basis and with cash to spend may lead to a limited increase in expenditure in hotels, restaurants and markets. Use of local service providers for supply of food and other goods will also have economic spin-offs for businesses in Beira. However, this is likely to have only a relatively limited and short term boost on the local economy.

Table 8.38 *Increased Revenue and Economic Benefits Due to Presence of Crew in Beira and Purchase of Local Goods and Services*

Nature of Impact	Expenditure by crew and the drilling project on goods and services will be relatively limited but will have a positive economic impact in the short term
Magnitude	**Magnitude – Low** *Extent*: **Local** – limited to Beira environs where workers would spend money and good and services will be supplied for the project. ***Duration:*** **Short-term** (limited to duration of drilling phase). ***Intensity***: **Low** (as limited to relatively small expenditure)
Likelihood	**Likely**
Significance	**Minor**
Degree of confidence	**High**

Mitigation Measures:
SPM-10 should provide opportunities for local Mozambican suppliers to tender for the provision of goods and services through a fair and transparent tender process.

Table 8.39 *Significance: Increased Revenue and Economic Benefits Due to Presence of Crew in Beira and Purchase of Local Goods and Services*

Phase	**Significance with embedded mitigation**	**Significance with additional mitigation**
Drilling	**MINOR +VE**	**MINOR +VE**
Post-Drilling (Residual)	**NEGLIGIBLE**	**NEGLIGIBLE**

8.2.14 Conclusion of Well Drilling and Testing Impacts

From the summary table it is evident that the impact of drilling and operational support activities will have minor or negligible effect on the marine environment. Most polluting activities are regulated under MARPOL standards for pollution control of sewage, waste and oily water and international drilling rigs are designed to comply with these standards.

The drilling impacts that are likely to be of most concern to stakeholders relates to the impact on fisheries. The proposed drilling activities are outside the key fishing zones (see *Figure 8.2*) and the plume of turbidity caused by drill cuttings with trace hydrocarbons is predicted, based on modeling results to be dispersed within a maximal range of 5-10 km of the drilling site and will therefore not extend into the fishing zones.

The consequences of a major oil spill are addressed in *Section 9.*

8.3 CUMULATIVE IMPACTS

Cumulative impacts are impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same environmental resource or receptor.

Cumulative impacts may occur on the following receptors:
- biodiversity;
- environmental quality (emissions, discharges, solid waste);
- infrastructure and services; and
- socio-economic and cultural effects.

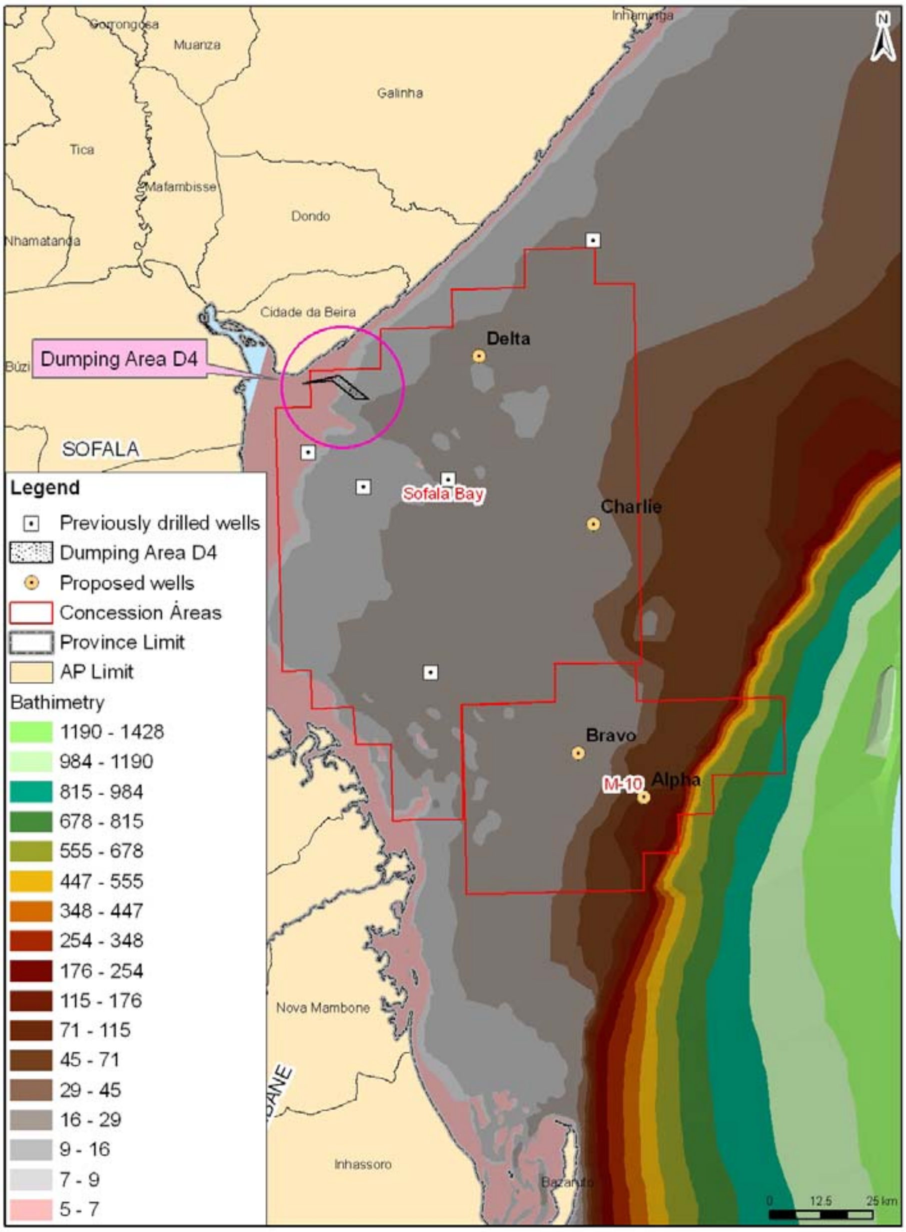
However the fact that the drilling will take place at sea over a relatively short duration (maximum of 120 days) suggests that cumulative impacts especially on the socioeconomic, environmental quality, and infrastructural and services receptors will be limited, if not non-existent.

Besides the proposed one or two wells in each concession, no other marine activities are currently underway or scheduled to occur in the M-10 concession that would have a cumulative effect on the marine environment. Five wells have previously been drilled in the Sofala Concession (see Figure 8.3) but these were located inshore of the proposed drilling sites so the drill cuttings settlement zones of these old sites will not overlap with the new proposed sites. Regardless, the sea floor would have largely recovered from the effects of the previous wells and no cumulative impact with previous drill sites on the sea floor is expected.

The dredging of Beira channel to create improved access to the port is currently underway in which an estimated 8 million m^3 of sediment will be dredged. This is in contrast to the approximate 505 m^3 of sediment to be discharged during drilling a 5,000 m deep well. Much of the sand dredged from the channel has been used for constructing a wall around the harbour and the mud has been disposed of to the marine environment to the east of Beira approximately 23km away. The deposition and/or turbidity zone arising from the deposition of muddy dredge material therefore likely occurs within the north eastern portion of the Sofala Concession. Plume dispersion modeling for the shallow water well site of Delta suggests that the majority of this dredge material may disperse towards the shore rather than offshore towards the possible drill location of Delta which is situated approximately 50 km from Beira, and hence, approximately 17 km east of the dredge deposition area. Therefore drilling and dredging effects are not likely to have a cumulative impact on the marine environment at the same location. Drilling also contributes a relatively minor proportion of sediment compared to the quantity of dredge material being disposed of from the Beira Channel.

Drilling of up to two wells in both the M-10 and Sofala concessions would have some minor potential cumulative impact on infrastructure and services and the local economy in Beira. On the one hand, accommodation of drilling staff in hotels in Beira, and associated spinoff expenditure, and the purchase of local supplies during drilling activities will have a positive benefit on the local economy. This would be cumulative over the duration of the project, and when combined with other projects in the area that is attracting foreign workers, such as the dredging project. On the other hand, increased workers in town can have negative impacts on health through increasing risk of transmitting HIV/AIDS and STDs etc. However the short duration of the drilling project suggests that these impacts would be of a relatively short term and temporary nature.

Figure 8.3 Location of Previous Wells Drilled and the Beira Channel Dredge Disposal Area in Relation to the Sofala and M-10 Concession Areas



9 OIL SPILL MODELLING AND IMPACTS

9.1 INTRODUCTION

Petroleum-based hydrocarbons enter the marine environment naturally by a variety of anthropogenic and natural sources. Anthropogenic land-based input (from urban and industrial sources) amount to approximately 37 percent of the total input with the remainder made up of vessel operations (33 percent), tanker accidents (12 percent), atmospheric deposition (12 percent), and natural processes and exploration and production activities (9 percent) (National Academy of Sciences, 1985).

However, the general public is highly aware and sensitised about the risk and consequences of oil spills in the marine and coastal environment, particularly in recent months as a result of the BP spill from a blow out well in the Bay of Mexico. This disaster arose as a consequence of a series of maintenance and equipment failures that could have been prevented if warning signals and correct maintenance and prevention procedures had been heeded and attended to. The consequence has been extensive damage to estuarine habitat, mangroves, fisheries and high economic impact on the inhabitants who derive their income from marine resources. (Bourne, 2010)

Accidental spillage has the potential to cause major environmental disaster events such as that arising from the Exxon Valdez (see Khan, 1992; Loughlin, 1994; Petersen *et al*. 2003; Huebeck *et al*. 2003). Such accidents may be caused by equipment failure, human error or natural events and can result in environmental disasters.

Accidental spills during hydrocarbon exploration and production activities may be divided into operational oil spills (relatively minor spills resulting from normal operations such as refuelling) and major accidental spills arising from drilling accidents (such as blow-outs where there is an uncontrolled release of sub-surface fluids) or storage and export accidents (including collisions with other shipping vessels, pipeline accidents or storage vessel accidents).

Although the likelihood of a well blow out or accidental spill from a collision is extremely remote, the consequences of such non-routine discharges have been modelled for this study (see *Section 9.2* below).

Oil spills for the drilling project could potentially arise from the following causes:

- Refuelling incident leading to a diesel spill
- Blow out of drilling well leading to release of condensate, and

- Collision of the drilling rig or support vessel with a tanker.

Each of these incident types are discussed below.

9.1.1 *Refuelling incidents*

Refuelling of drilling rigs with diesel oil is required every few days during drilling activities during which time 1,000 to 1,500 barrels of diesel will be transferred. The refuelling process can take up to two to three hours to complete. The most common form of spillage occurs from fuel handling accidents and is usually caused by hose rupture, coupling failure or over filling of fuel tanks.

International data on the probability of oil spills indicate that the probability of a spill from a rupture of a fuel transfer hose is 1 in 50 during a 25 day drilling programme (EPA Bulletin 853, as referenced in EPA, 2001). This probability can be substantially reduced by using wire reinforced hoses, dry-break couplings and refuelling under tide and wind conditions that make refuelling easy and safe (EPA, 2001).

9.1.2 *Loss of well control (blow out)*

The worst case spill scenario that has been modelled is a blow-out resulting in a large spill of condensate.

The volume that could be spilled will depend on the permeability and thickness of the oil producing strata, the viscosity of the oil, the number and type of obstructions in the well hole, and the time taken to regain control and seal off the well. International data on the probability of oil spills indicate that the probability of a blow-out in the order of 6,000 litres (3,750 bbls) occurring during a drilling programme is about 1 in 25,000 (EPA Bulletin 853, Table 2, as referenced in EPA, 2001).

In the Gulf of Mexico, more than 15,000 wells have been drilled between 1992 and 2006, during which time there have been 39 blowouts, few of which released much oil, and most were stopped within a week, and resulted in one death (Bourne, 2010). In the history of the Australian oil and gas industry, there have been six blow-outs, the majority in 1960 and the last in 1984 (Volkman *et al.*, 1994 as referenced in EPA, 2001). All of these blowouts were gas/condensate blowouts and none resulted in any significant oil spill.

The risks of well blow outs occurring have decreased as technology and preventive measures have improved over the years. Extensive seismic surveys and site analyses are carried out before actual drilling to minimise the possibility of encountering over-pressured sediment strata. The composition of the drilling fluids (mud) is constantly monitored to ensure the pressure is neither too high, which would damage the rocks being drilled, nor too low, which could allow fluids (gas, water or oil) in the rock to blow-out at the surface. Should a blow-out appear imminent the driller is warned through monitoring equipment and blow-out preventers [BOP] and automatic shut-in valves can be activated to close off the hole.

In recent years the Environmental Protection Authority of Australia has assessed several exploration drilling, appraisal and gas/condensate production proposals in sensitive marine environments. They have recognized the low probability of a substantial oil spill from properly managed petroleum industry activities and have recommended in the Australian EPA Bulletins 853, 856 and 914 that they could proceed subject to strict procedures and legally enforceable conditions (EPA, 2001).

The high potential revenues generated by the oil and gas industry, and worldwide demand for hydrocarbons, tends to outweigh the risk of environmental damage associated with drilling, based on implementation of the highest technological control and preventive measures in accordance with international best practice.

9.1.3 Vessel Accidents

The international literature on the environmental impacts of oil spills resulting from vessel accidents is extensive, and arises from a number of major vessel incidents, such as the Exxon Valdez in Alaska in 1989. Vessel accidents can lead to the release of large quantities of heavy fuel oil, depending on the type of vessel involved and the quantity of oil it is carrying.

Over and above oil spill impacts, vessel accidents can impact the environment through a number of pathways including physical reef destruction (Marshall and Edgar 2003), dispersal of anti-fouling compounds from the vessel hull (Haynes *et al*., 2002) and as a chronic source of dissolved iron resulting in long-term changes in ecosystems.

Despite low probabilities of occurrence, oil spill scenarios have been assessed as described in *Section 9.3.3*. It should be noted that impacts are assessed based on the likelihood of an impact arising once an oil spill has occurred, and no probabilities of oil spilling has been incorporated into these assessments.

9.2 PHYSICAL AND BIOLOGICAL FATE OF OIL IN MARINE ENVIRONMENT

9.2.1 *The Nature and Physical Fate of Oil and Associated Compounds in the Marine Environment*

Almost all stages of hydrocarbon exploration and production may result in discharges to the marine environment in various quantities (the proportions of which often depend on the stage of exploration or production in the life of the field). Fluids contained in oil accumulations are a mixture of a number of organic and inorganic compounds, but primarily hydrocarbons. These fluids vary considerably in their appearance from gases to viscous black liquids. Such variation arises from the manner in which carbon atoms are able to bond into single or branched chains. Crude petroleum may contain organic compounds ranging from those low in molecular weight to compounds with molecular weight of 10,000 or more.

There are a number of non-hydrocarbon components of oil, including sulphur compounds, nitrogen compounds, metalo-porphyrins and asphaltenes.

The following introduction to the fate of oil in the marine environment is synthesized from Geraci and St Aubin (1990) and Kingston (2002).

The ultimate fate of oil in the marine environment will to a major degree depend on the nature of the oil, although environmental factors (for example, temperature, wind, current and substrate type amongst others) will influence the fate of oil. Oil discharged into the marine environment will immediately transform and breakdown through a number of different physical, biological and chemical processes (summarised in *Figure 9.1*).

Generally after initial surface spreading, the oil slick will lose components to both the atmosphere through evaporation and to the water column through solubility. Light fractions will evaporate, water soluble components will dissolve (termed the water soluble fraction), while the immiscible (non-mixing) components emulsify, aggregate or settle into sediments.

Initial Surface Spreading

Oils will initially spread as a thin film over the water surface depending on concentrations and water soluble fractions, sea temperature and oil type. Slicks will usually travel downwind at approximately three to four percent of the wind speed with a limited direction shift due to Coriolis force. Spreading is more rapid in warmer conditions due to increased viscosity. On calm water a visible sheen can form at oil concentrations of 25 ppm.

Evaporation

Evaporation of low molecular and aromatic components of the oils begins within minutes of the spill incident and is dependent on the surface area of the slick, the type and composition of the oil and the environmental conditions (particularly temperature). Hydrocarbons evaporate more slowly from colder waters. The loss of the volatile compounds reduces vapour pressure and toxicity, and at the same time increases both the density and viscosity of the slick (possibly resulting in increased emulsification). Evaporation includes most of the toxic components (Kingston, 2002): at least 30 percent of the oil spilled by the Exxon Valdez (35,000 tonnes) and as much as 40 percent of the Amoco Cadiz oil (240,000 tonnes) was estimated to evaporate, while over half the cargo of oil spilled by the Jessica in the Galapagos in 2001 was a light oil (diesel) almost all of which evaporated.

Dissolution

Most oil compounds, particularly the low molecular weight aliphatic and aromatic components are water soluble to some degree and are relatively toxic. This dissolution component is small and less than one percent of spilled oil may become quickly diluted and degraded.

Dispersion

Dispersion is probably responsible for the natural removal of a large proportion of the oil that does not evaporate rapidly from the water surface slick. The oil is broken up by wave action into small droplets (0.01-1 mm in diameter) which are retained in the water column until degraded by bacterial action. Typical concentrations of hydrocarbons under slicks are low, although they can reach concentrations of several parts per million for short periods under extenuating circumstances.

Emulsification

Emulsification is dependent on both oil type and agitation so that wave action and sea conditions play an important role in emulsification, so that emulsions are particularly prevalent in rougher sea conditions. Both oil-in-water and water-in-oil emulsions may form depending on the viscosity, thickness and chemical composition of the oil and the local environmental conditions. Water in oil emulsions may persist for some time in “mousse” forms (which may contain 20–80 percent seawater). Such “mousse” may be of particular concern in the acute impacts of wildlife smothering.

Photo-chemical reactions

Photo-degradation through photo-oxygenation act on oil in the water, resulting in products which often have both increased toxicity and water solubility, and include hydroperoxides, phenols, ketones and aldehydes. Direct photolytic reactions are an important mechanism in molecular transformation. Kingston (2002) suggests that concentrations of these by-products of photo-degradation are generally too low to be of ecological significance.

Sedimentation (including bio-sedimentation)

Sedimentation occurs when oil components are adsorbed to suspended material and deposit to sediments on the seafloor, by the direct sinking of heavy or weathered oils or stranding of oil slicks. The decomposition rate of oil under anaerobic seafloor conditions slows considerably, and oils within sediments may persist for considerable time. In particular, armouring by boulders, cobbles or pebbles (which limits exposure to wave action) may increase such persistence. This process is more pronounced in low energy systems, where tidal influence and wave action is absent.

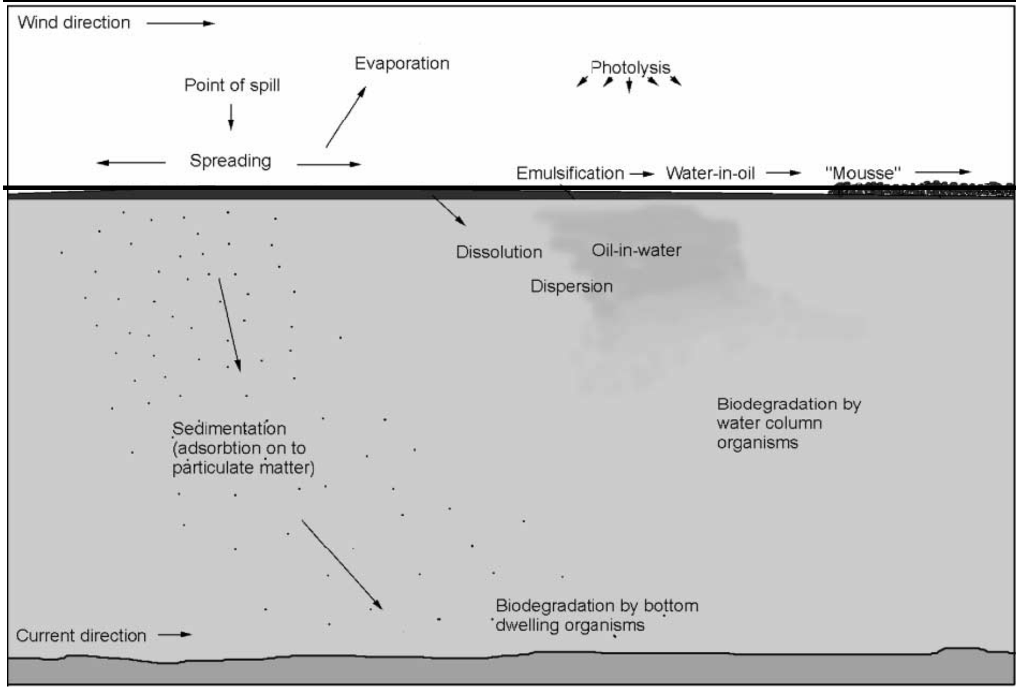
Microbial breakdown and biodegradation

The rate of biodegradation of oils is dependent on primarily the molecular structure of the oil concerned, with alkanes biodegrading more rapidly than aromatic substances. Further factors include temperature (with very low rates of microbial breakdown in cold waters), nutrient and oxygen concentrations of the surrounding water, and the abundance of biodegrading organisms. Dissolved oxygen levels in the associated environment may be reduced under calm conditions during biodegradation.

Aggregation

Oil aggregates (“tar balls”) arise after the evaporation or dissolution of light components, and emulsification and chemical and microbial transformation. They usually comprise the high molecular weight components of the oil.

Figure 9.1 Pathways by which spilled oil may enter the marine ecosystem (after Kingston, 2002



9.2.2 *The Biological Fate of Oil in the Marine Environment*

Oil hydrocarbons and other substances discharged into the marine environment during hydrocarbon exploration and production have a range of impacts on biota from mechanical and toxic to mutagenic effects. There is a large volume of literature on the effects of oil on marine organisms and ecosystems (eg Teal and Howarth, 1984; Volkman *et al,* 1994; Holdway, 2002; Petersen *et al*, 2001; Kingston, 2002). Generally, effects of oil in the marine environment can be divided into acute and chronic impacts. While acute impacts have often been identified at the single species individual level (which may induce longer-term population level impacts), chronic impacts often involve trophic or ecosystem level disruption.

Acute Impacts

Recent studies of acute toxicity of crude oil on marine species have been reviewed by Holdway (2002). The acute impacts of pollutant substances can generally be grouped on the basis of their impact on the marine environment into:

- mechanical impacts of smothering of sessile organisms or impacts to respiratory systems or digestive systems; skin, fur or feathers, where direct contact with oil results in loss of insulation properties and ingestion of toxic hydrocarbons during preening or grooming;

- eutrophication (nutrient-enrichment) effects;
- oxygen depletion or saprogenic effects;
- toxic effects; resulting from exposure to skin, or the respiratory or digestive tracts of organisms; and
- carcinogenic, mutagenic and teratogenic effects.

Toxicity effects of polycyclic aromatic hydrocarbons (PAH's) and similar contaminants varies between species and largely depends on the form of the contaminant, route of exposure and stage in the life-cycle of the organism (Hall, 1983). Chronic or high-level exposure to PAH's or crude oil is a contributing factor in health and reproductive problems in many wild species such as brown bullheads, *Ameiurus nebulosus* (Steyermark *et al*., 1999), darter gobies, *Gobionellus boleosoma* (Klerks *et al*., 1997), gray seals, *Halichoerus grypus* (Jenssen, 1996), and loggerhead turtles, *Caretta caretta* (Alam and Brim, 2000).

While acute impacts are generally short term in nature, it should be noted that they might result in long term effects.

Chronic impacts

There is an increasing body of literature on the chronic and sub-lethal effects of crude oil on aquatic organisms (including behavioural effects; suppressed growth; induced or inhibited enzyme systems; physiological responses; reproductive effects; suppressed immunity to disease or parasites; pathological effects; tainted flesh and chronic mortality). Petersen *et al*. (2003) in reviewing the ecosystem responses to the 1989 Exxon Valdez oil spill identified three major pathways of long-term impacts, where effects were transmitted well beyond the acute mortality phase:

- Chronic persistence of oil, biological exposures and population impacts of species closely associated with shallow sediments. Populations of otters, seabirds and fish that were intimately associated with sediments for foraging or egg laying showed evidence of chronic exposure (through biomarkers) for some years after the spill. Such exposure included fish fry and larvae exposure to polycyclic aromatic hydrocarbons (PAH's) for up to four years after the spill. Furthermore, high levels of the detoxification enzyme CYP1A were recorded in sea otters preying on suspension feeding clams and mussels from oiled areas. Similar induction of CYP1A by harlequin ducks, barrow's golden-eyes and guillemots showed ongoing exposure to the spill nine years later, and resulted in reduced survival of the exposed ducks.

- Delayed population impacts of sub-lethal dosages resulting in compromised health, growth and reproduction. These impacts included delayed growth rates and reduced survival of exposed salmon fry, and (in laboratory studies) reduced survival of embryos of adults previously exposed to weathered oil as embryos and fry. Black oystercatchers showed reduced breeding and smaller egg sizes on oiled shores. Furthermore birds on oiled shores showed lower chick survival (through slowed growth rates) up to three years after the spill.

- Indirect effects of trophic and interaction cascades. Indirect cascading effects result through a change in an intermediary, and are consequently often delayed. These include lengthened recovery processes on rocky shorelines.

Petersen *et al* (2003) noted that four major new research approaches were necessary in a paradigm shift from the acute toxicity-based approach to an ecosystem-based approach that investigates short-term effects, and longer term chronic, delayed and indirect impacts in oil toxicology studies. These included:

- Oil weathers at varying rates dependent on environment, with subsurface sediments with limited agitation, oxygenation and photolysis retaining unweathered oil for years. Such unweathered oils may be bioavailable over long-term periods.

- Oil toxicity to fish may be long term (through exposure to PAH's), rather than short term through the oil water soluble fraction, leading to long-term effects on growth, behaviour, reproduction and mortality.

- Oil toxicity to seabirds and mammals extend well beyond the acute short term exposure of fur, skin or feathers (which lead to death from hypothermia, smothering, or ingestion) to long-term chronic toxic effects from trophic and ecosystem interactions.

- Impacts to coastal faunal communities extend beyond the acute mortality arising from short-term toxic exposure and smothering to cascades of delayed impacts (especially trophic cascades and biogenic habitat loss) over the long term. Clean-up attempts using chemical dispersants and causing direct habitat damage (eg saltmarsh trampling) may be more damaging than the oil itself.

To understand the consequences of an oil spill incident various spill scenarios were modelled under different meteorological and oceanographic conditions. The oil spill scenarios simulated are summarised in *Section 9.3*.

9.3 OIL SPILL MODELLING

9.3.1 *Approach*

ERM contracted Applied Science Associates (ASA) to undertake a modelling study of a hypothetical oil spill from two defined well site positions within each of the two Concessions: M-10 and Sofala (see report in *Annex E*). Approach and results of modelling a condensate blow out spill and a release of heavy fuel oil from the Delta well site in the Sofala Concession is described below.

Simulations of spills of condensate and heavy fuel oil were completed using ASA's OILMAP oil spill modelling system. OILMAP inputs include shoreline definition, area circulation features, long-term wind time series, spill locations and oil properties. The OILMAP stochastic model output includes sea surface and shoreline areas that could potentially be oiled and the associated probability of oiling, as well as the time required for oil to reach the predicted impact areas. The OILMAP deterministic trajectory/fate model output includes a time history of oil weathering over the duration of the simulation, expressed as the percentage of spilled oil on the water surface, on the shore, evaporated, and entrained in the water column.

9.3.2 *Surface Oil Spill Simulation*

Two potential oil spill events were defined by the client: a large blowout spill of condensate - a very light hydrocarbon, and a small spill of a heavy fuel oil (HFO).

The blowout event has been simulated assuming that the entire volume of the condensate released at the seabed will quickly reach the water surface generating a surface slick. The condensate blowout has been simulated as a continuous surface spill transported by winds and surface currents.

The spill site locations (*Table 9.1*) were identified as the probable approximate drilling sites. *Table 9.2* summarizes the criteria on which the simulations were performed at the two well sites while *Table 9.3* summarises the oil properties used in the simulations.

Table 9.1 Location of Drilling Sites Used for Oil Spill Modelling

Name	Concession	Latitude	Longitude	Distance to Coast
Bravo	M-10	35°31′09″E	20°41′41″S	50 km
Delta	Sofala	35°18′34″E	19°49′08″S	20 km

Table 9.2 *Scenario Criteria for Condensate and Heavy Fuel Oil Spill*

Scenario Name	Location	Name	Period	Oil Type	Volume	Spill duration
D-BO	Delta	Blowout	Mar-Nov	Condensate	500 ton/day	2 months
D-HFO	Delta	HFO Small	Mar-Nov	Heavy Fuel Oil	250 ton	Instantaneous

The duration of the simulations has been defined as 14 days for the HFO spill and 68 days (2 months + a week) for the condensate blowout. The total amount of condensate used in the simulation was 30,500 tonnes. Water temperature was assumed to be 26°C which was the average value for the March to November drilling period (selected for drilling as it is outside of peak cyclone season).

Table 9.3 *Summary of Oil Characteristics*

Oil Type	API Gravity	Density (g/cm3)	Viscocity (cP)	Surface tension (dyne/cm)	Maximum Water Content
Condensate	60	0.7399	0.766	18.4	0%
Heavy Fuel Oil	12	0.9860	8706	32.5	35%

Viscosity and interfacial surface tension are used to determine the spreading of the surface oil, which in turn influences the rates of evaporation, dissolution, dispersion, and photo-oxidation (processes discussed in Section *9.2* above). The maximum water content indicates the emulsion-formation tendency of the oil. Oils that form emulsions tend to be persistent on the water surface, thus increasing their shoreline impacts. The HFO has relatively moderate water content and emulsifies, while the zero percent water content of condensate indicates that condensate does not emulsify.

9.3.3 Oil Spill Modelling Results

Stochastic Model Results

The OILMAP stochastic model was used to predict probabilities of sea surface oiling due to a hydrocarbon spill, and is based on a mix of individual simulations, each with a different start time selected randomly from the specified season or period (winter or summer) during the ten year wind record. In this way, the modelling included variability of wind forcing.

The sum of the sea surface trajectories from the individual simulations defines the expected water surface footprint for each spill scenario. This footprint represents the likely area of sea surface impact from a spill for that location and season. The probabilities of water surface and shoreline oiling and the minimum travel times for surface oil are provided for the area within the footprint. The stochastic results provide insight into the probable behaviour of potential oil spills under the wind and current conditions expected to occur in the study area during a given season. Only surface oil predicted to be thicker than 200 nanometers was used to generate the probabilities and minimum travel times shown in the figures. This is a conservative minimum thickness for surface oil that represents a barely visible slick. Results of the stochastic model predictions are presented in the following figures.

For each scenario (condensate blow out and heavy fuel oil spill), two figures are presented:

- Probability of surface oiling.
  This map shows the area in which sea surface oiling may be expected and the probability of oil reaching the area, based on the trajectories from the ensemble of independent simulations. The plot does not imply that the entire coloured surface presented would be covered with oil in the event of a spill. The plot does not provide any information on the quantity of oil in a given area (water surface or shoreline); it only shows the probability that some oil reaches the area.

- Minimum travel times.
  The footprint on this map corresponds to the footprint on the probability map, and shows the shortest time required for oil to reach any point within the footprint based on the ensemble of independent simulations.

It is important to note that the figures showing water surface oiling probabilities and travel time contours do not depict the sea surface area that will be oiled in the event of a major oil release but rather the probability of oil being present at a particular location, or time to oil arrival at that location.

Shoreline impacts for the modelled condensate and heavy fuel oil spill scenarios are summarised in *Table 9.4*. It gives the percentage of simulations in which oil was predicted to reach shore, the maximum and average amount of oil to reach shore and the minimum and average time for oil to reach shore.

Table 9.4 Summary of Stochastic Results from a Potential Blow Out of Condensate and Heavy Fuel Oil Release at Delta, Sofala.

Scenario	**Type/Spill Volume**	**Simulations hitting shore***	**Amount of oil ashore (tonnes)**		**Time to reach shore (days)**	
			Maximum	**Average**	**Minimum**	**Average**
Delta -BO	Condensate 500 t/day	100%	4575 (15%)	2063 (7%)	1.0	5.2
Delta - HFO	HFO 250 tonnes	98%	218 (87%)	204 (82%)	0.6	3.2

* Only simulations leading to an impact of more than 0.1% of the total spilled mass are included here

Conclusions of the oil spill modelling stochastic results:

- All spill scenarios from Delta lead to a high probability (>98 percent) of some degree of shoreline impact because of proximity of the well to the coast (approximately 20 km), and the predominant southeast winds that push the hydrocarbon spill towards the coast.

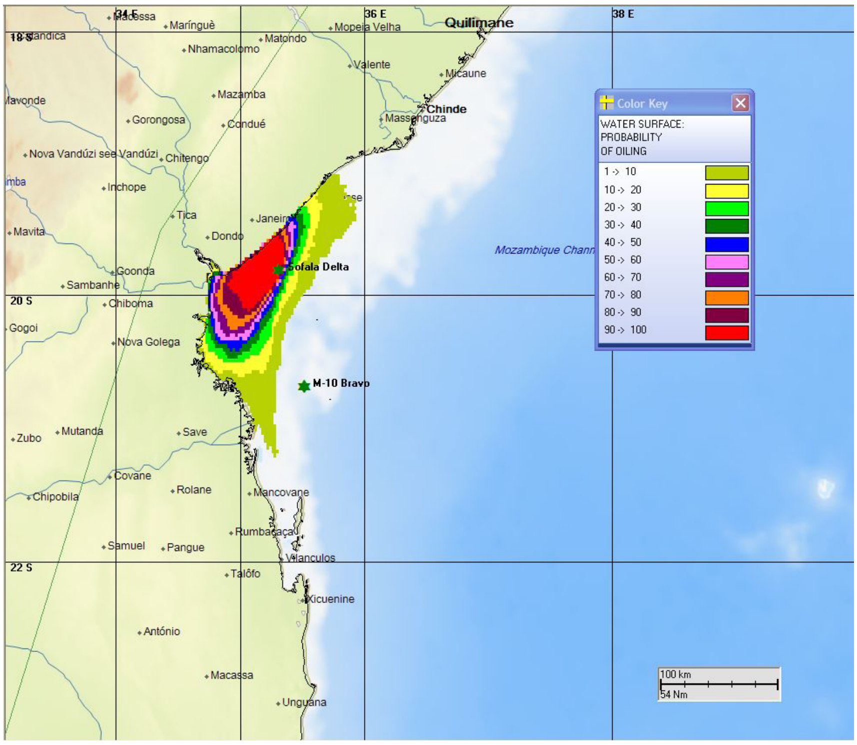
- Based on simulation modelling, a condensate spill from Delta of 500 tonnes per day has a 100 percent chance of hitting shore with an average amount of 2063 tonnes (7 percent) or a maximum of 4575 tonnes (15 percent) within 5.2 days on average or a minimum of 1.0 day.

- A HFO spill of 250 tonnes has a 98 percent chance of hitting shore with an average of 204 tonnes (82 percent) or a maximum of 218 tonnes (87 percent) within an average of 3.2 days or a minimum of 0.6 days. A heavy fuel oil spill would therefore be potentially more severe than a condensate spill as a much higher percentage reaches the shore within a shorter time frame.

- Although the total volume released in the condensate blowout scenario (30,500 tonnes) is significantly larger than the heavy fuel oil (HFO) spill scenario (250 tonnes), the percentage of predicted volume of condensate impacting the coast is smaller due to its higher evaporation rate. After 68 days (the end of the simulation) there is no condensate left in the water or on the shoreline.

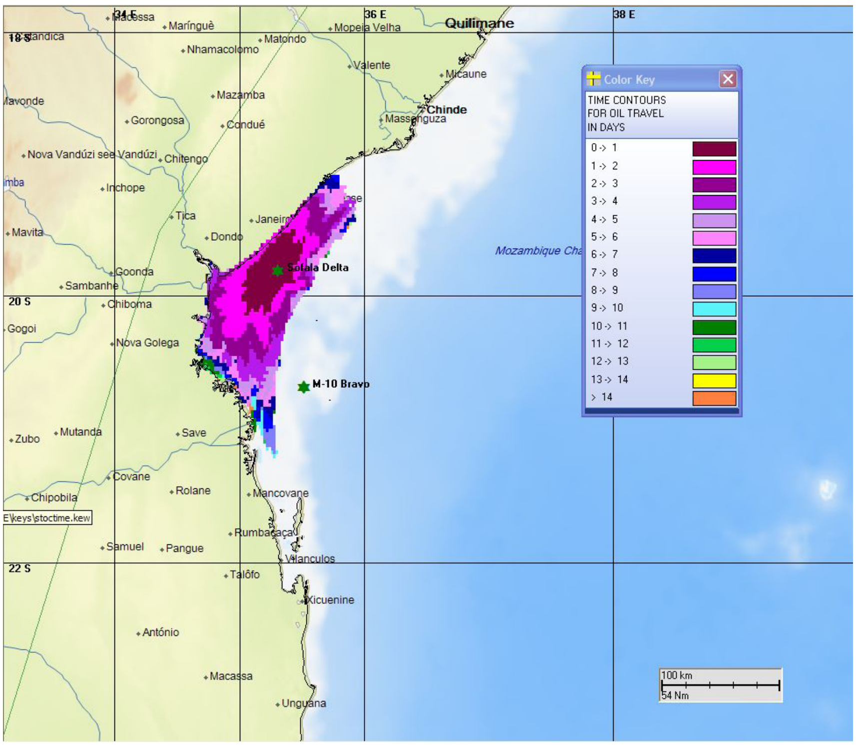
Interpretation of these modelling results for the Sofala Bay area is given in *Section 9.3.6* to *Section 9.3.9*.

Figure 9.2 *Probability of Water Surface Oiling for Condensate Blowout at Delta, Sofala*



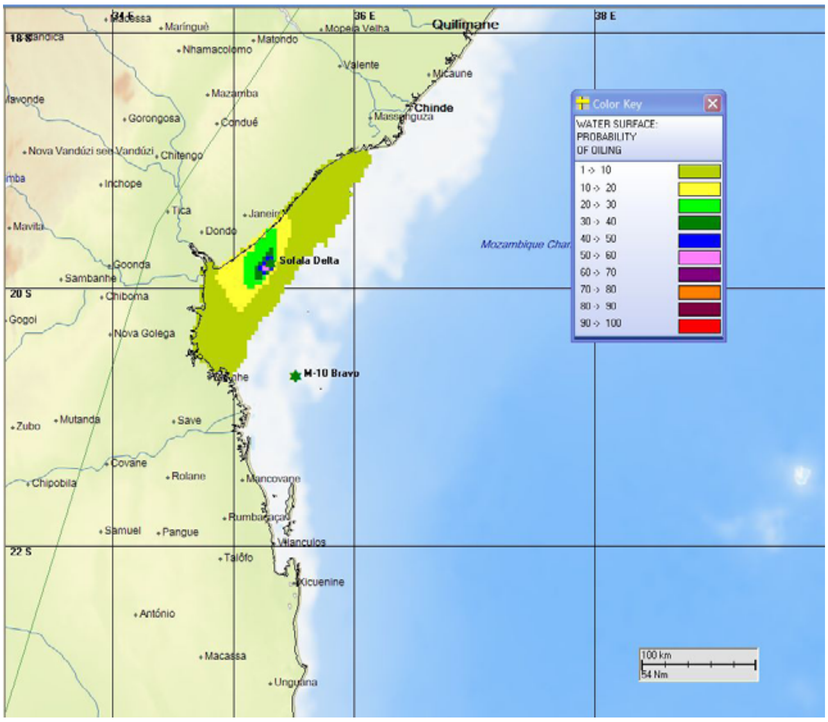
Source: ASA, 2010

Figure 9.3 *Time Contours for a Condensate Blowout at Delta, Sofala*



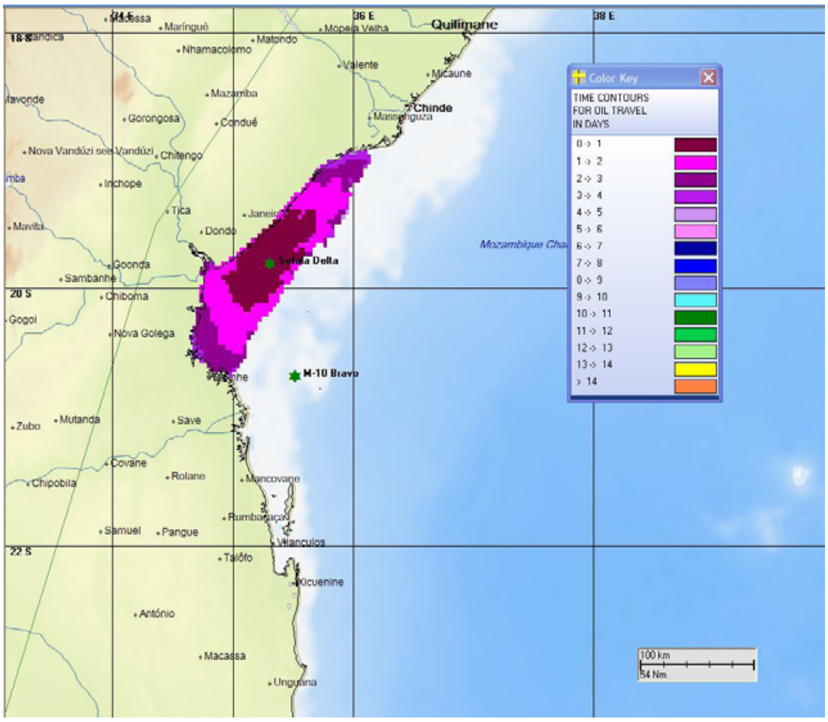
Source: ASA, 2010

Figure 9.4 Probability of Water Surface Oiling from Heavy Fuel Oil Spill at Delta, Sofala



Source: ASA, 2010

Figure 9.5 Time Contours for a Heavy Fuel Spill at Delta, Sofala



Source: ASA, 2010

Deterministic Model Results

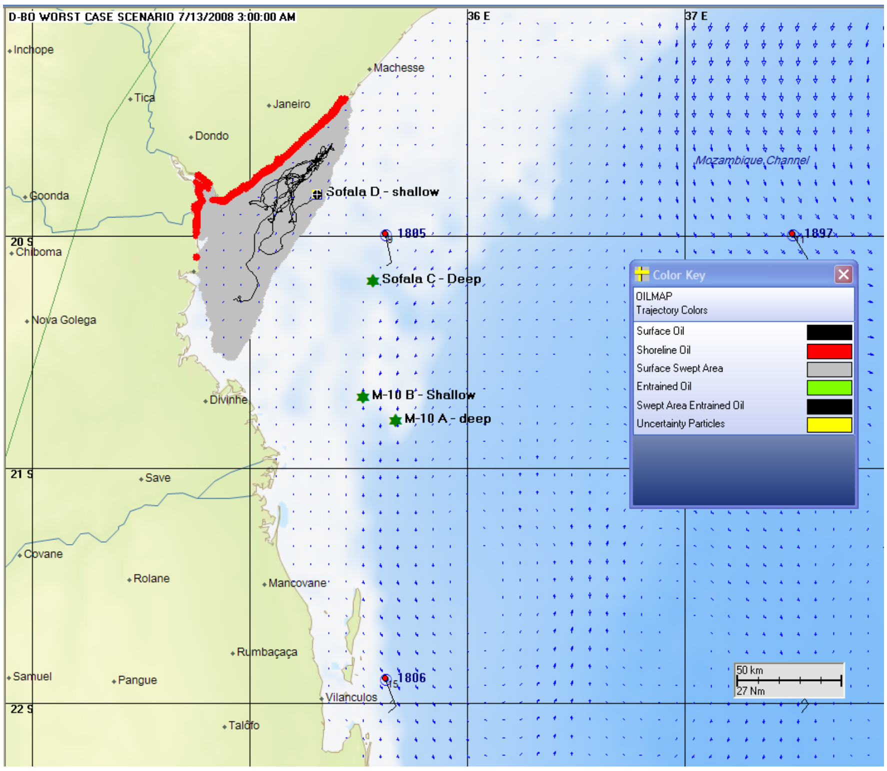
For a condensate blow out and a heavy fuel spill scenario, a deterministic trajectory/fates simulation was performed based on a representative simulation identified in the stochastic analysis that predicts significant shoreline impacts. The selected scenarios represent the worst wind and current conditions which result in maximum shoreline impacts. The deterministic simulation provides a time history of oil weathering over the duration of the simulation, expressed as the percentage of spilled oil on the water surface, on the shore, evaporated, and entrained in the water column.

Results of the deterministic trajectory/fates simulations are shown in *Figure 9.6* and *Figure 9.9*.

There are two figures for each spill scenario. The top figure shows the footprint of the spill's trajectory on the water surface at the end of the simulation period. The oil-swept area is colour-coded to indicate time since the start of the spill.

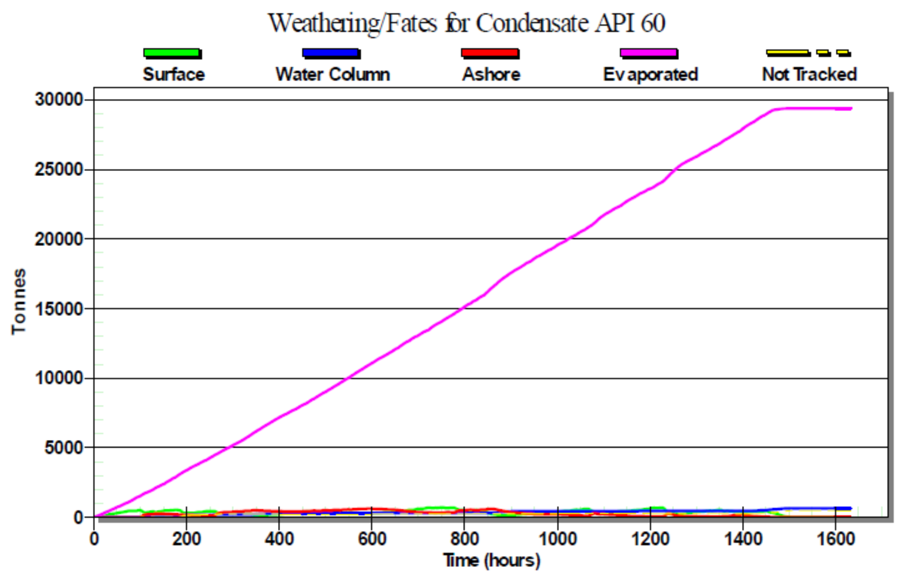
A track line indicating mean oil position as the oil moves to shore is shown in black. The model-predicted mass balance for the spilled oil is displayed on the bottom half of the page (*Figure 9.7* and *Figure 9.10*). The mass balance graph shows the degree of weathering that the oil undergoes during the simulation period.

Figure 9.6 *Worst Case Model-Predicted Water Surface Signature for Condensate Blowout at Delta, Sofala. {Grey is the swept area, Red is the shoreline impact}.*



Source: ASA, 2010

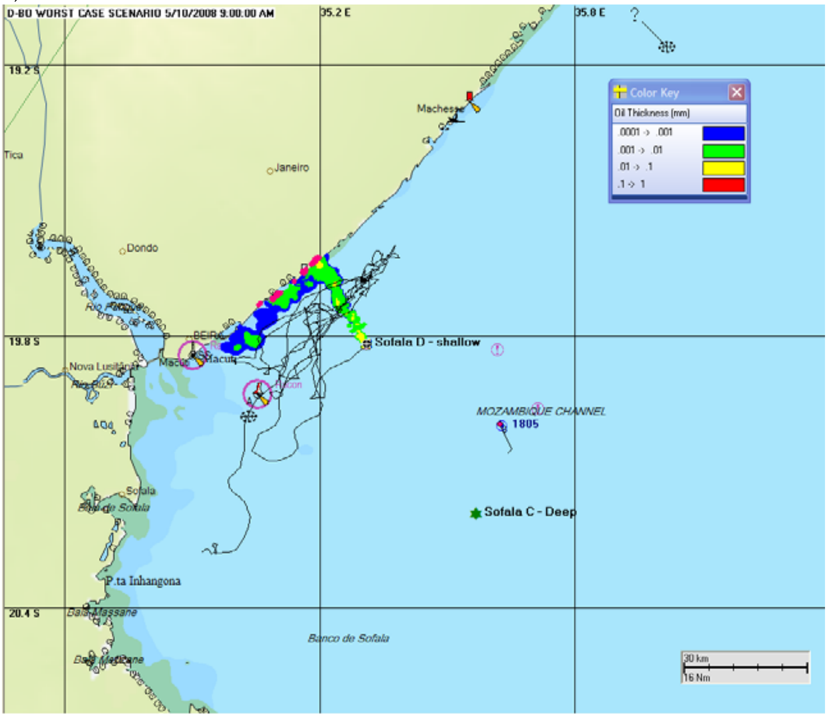
Figure 9.7 *Worst Case Model-Predicted Mass Balance for Condensate Blowout at Delta, Sofala*



Source: ASA, 2010

Figure 9.8 Worst Case Model Predicted Condensate Thickness Contours at Two Different Times for Blow Out at Delta, Sofala: a) 4 days later (first coastal impact), and b) 61 days later. {Pink = impacted shoreline}

a)



b)

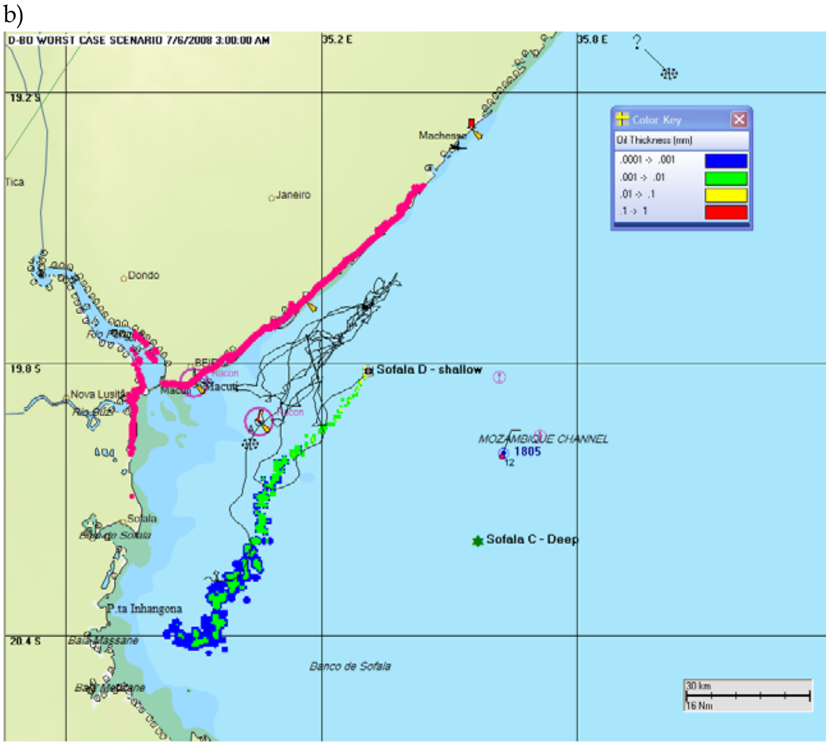
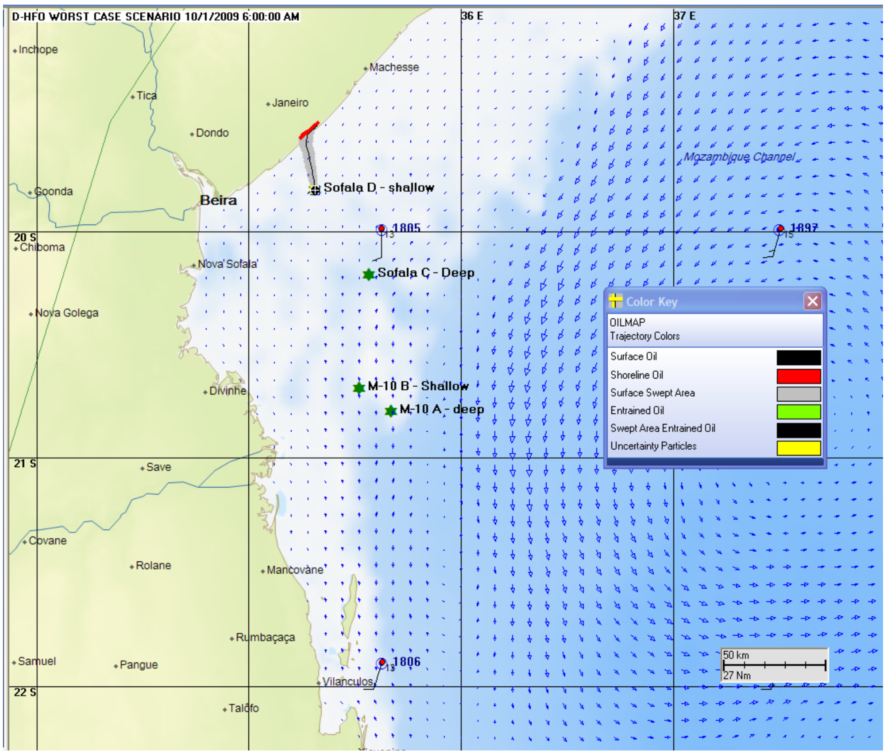
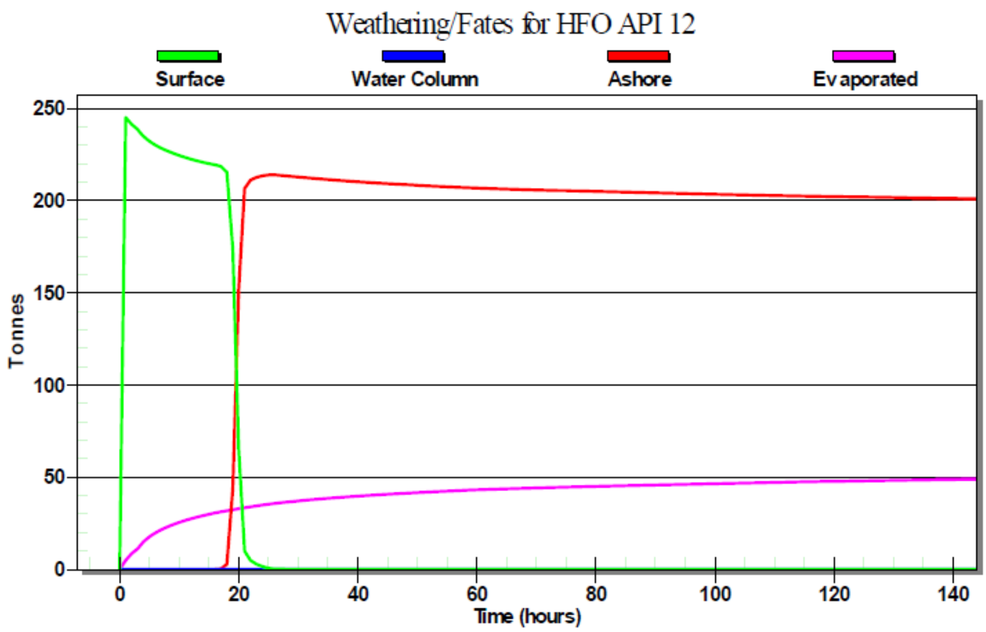


Figure 9.9 Worst Case Model Predicted Water Surface Signature for HFO Spill at Delta, Sofala. {Grey is the swept area, Red is the shoreline impact}. No surface oil remains after 14 days.



Source: ASA, 2010

Figure 9.10 Worst Case Model-Predicted Mass Balance for HFO Spill at Delta, Sofala.



Source: ASA, 2010

9.3.4 *Conclusions of Oil Spill Modelling*

In summary, the oil spill modelling results indicate the following:

Condensate

A 30,500 tonne spill of condensate (spilled at a rate of 500 tonnes per day over a period of two months under worst case scenario conditions) at Delta drill site would have a 70-80 percent chance of a surface oiling reaching up the Pungue River estuary within 3-4 hours, and a 1-10 percent chance of oiling surface waters around the Save River Estuary within 7-8 hours. Depending on the season, surface water oiling near Save River might be pushed away from the area by outflow from the river and in this scenario may not enter the estuary. The surface waters south and north of Beira would have a high likelihood of oiling and this would likely impact on salt pans and the aquaculture project north of Beira.

Condensate from a blow out of the modelled magnitude would extend along the coastline north of Beira across an estimated 50 km within 4 days but shoreline oiling could exceed 200 tonnes within 1-2 days. After 61 days the shoreline impact would extend from just south of the Buzi estuary northwards to Machesse with a plume of condensate extending southwards towards the coast after 61 days (*Figure 9.8*b).

It must be noted that condensate evaporates rapidly and the area of impact would, under these worst case conditions, only be affected by oiling to a very minor degree. An estimated 15 percent of the predicted volume of condensate can be expected to reach the coast due to its high rate of evaporation, amounting to 4575 tonnes, and all condensate would have evaporated from the surface water and coastline within 68 days.

An estimated 70-80 percent of a small spill of light condensate can evaporate within the first day but this will depend on the rate of continuous discharge into the environment in the very unlikely event a blow out should occur. Condensate disperses to a significantly lower degree than diesel, resulting in lower water column impacts than for diesel. A diesel spill would, however, be expected to follow a similar spread and trajectory as condensate.

Heavy Fuel Oil

In the event of an instantaneous heavy fuel oil spill of 250 tonnes at the proposed Delta drill site, the modelled spread of water surface oiling follows a similar trend to condensate, involving an outward and south and northward trend up and down the coastline. Most of the HFO would remain nearer the well site than for a condensate spill and it is predicted to drift towards the nearest coastline in close proximity to the salt pans and aquaculture farm.

There is modelled 1-10 percent chance of water surface oiling reaching the Pungue and Buzi estuaries or travelling further up the coast beyond Massenguza within 3 – 4 days. A heavy fuel oil spill of 250 tonnes is not predicted to reach as far south as the Save River.

A heavy fuel oil spill, due to its lower evaporation rates, would result in a greater proportion of the 250 tonnes reaching the coast. An estimated 218 tonnes (or 87%) is expected to come ashore, concentrated in a small area to the north of Beira, somewhere in the region of the aquaculture farm and salt works

Overall, modelling results suggest that both a condensate and a heavy fuel oil spill would cause extensive oiling of the sea water surface oiling around the Beira region of Sofala Bay, and lead to a small degree of oiling by condensate of the length of coastline from the Save River in the south, north towards Machesse, while the HFO spill is predicted to lead to some oiling of the coastline north of Beira.

9.3.5 *Summary of Potentially Impacted Habitats*

Habitats that could be impacted in the event of a well blow out of condensate or a collision with a vessel carrying heavy fuel oil are summarised in *Table 9.5*. Impacts on sensitive habitats, species, fisheries and other sea users are described and assessed in *Section 9.3.6.*

It must be stressed that the results of the oil spill modelling study represent a worst case scenario, and do not include any intervention such as containment, skimming and the use of dispersants. However, given the low accessibility of much of the coastal area bordered by mangrove forests along Sofala Bay, the use of booms, and skimming equipment and dispersants may not be effectively applied anyway. Therefore the impacts are assessed under this worst case scenario. The reader should bear in mind that the risk of an oil spill occurring – either through a vessel collision with the drilling rig or from a condensate blow out, during the 120-day well drilling and testing period, is exceedingly remote. The risk could be estimated as having a chance of 1 in 25,000.

Table 9.5 *Potentially Impacted Habitats from Oil Spill Scenarios*

Type of Spill	Impacted Area: Surface water oiling	Impacted Area Beached Oil	Potentially Impacted Habitats or Coastal Features
Condensate Spill.	Machesse to the north of Beira (1-10 % probability) south across Beira coastline (100% chance of reaching shore) and south to Save River Estuary (1-10%).	Coastline from south of Machesse to Beira and south to Sofala, including the Pungue / Buzi estuaries.	• Mangroves in Sofala Bay and Buzi and Pungue Estuaries. • Clam beds near Beira • Salt works and aquaculture farm north of Beira
Heavy Fuel Spill .	Machesse to the north of Beira (1-10 % probability) south across Beira coastline (98% chance of reaching shore) and south to Ilha de Chiloane (near Divinhe).	Predicted to be limited to a small stretch of coastline north of Beira.	• Unknown but likely to be sandy beaches, and possibly the salt works and aquaculture farm north of Beira.

9.3.6 *Consequences and Effects of Oil Spills on Sensitive Habitats and Species*

A summary of the effects of oil spills on sensitive habitats and species known to occur in the study area is provided in *Table 9.6*. The information is consolidated from a comprehensive review of scientific studies on the effects of oil spills, and serves as context for the assessment of impacts.

Table 9.6 Vulnerability of Sensitive Habitats and Species to Oil Spill Effects

Habitat, Communities or Species	**Vulnerability to Oil**	**References related to oiling**	**Location in Project Area**
Sub-tidal zone	• Change in community structure with a decrease in hydrocarbon sensitive species eg, crustaceans, and altered composition of opportunistic species, eg polychaetes, oligochaetes, and sometimes increased algal biomass due to increased nutrient availability in the photic zone.	Houghton, *et al*, (1991); Cabioch *et al* (1978); Corredor *et al* (1990); Dauvin (1987); Lee & Page (1997).	Entire coastline
Coral Reefs	• Toxicity effects leading to decreased growth, reproduction and recolonisation ability; negative effects on feeding and behaviour, and alteration of secretory activity of mucous cells. In general, oiling tends to result in reduced coral colony size and diversity.	Marshall & Edgar (2003); Guzman *et al* (1991); Harrison *et al* (1990); Jackson *et al* (1989); Fucik *et al* (1984); IPIECA (1993).	Bazaruto Archipelago
Sea Grass Beds	• Smothering of leaves and stems • Oil can form conglomerates with sediment on the sea grass and can lead to destabilisation of sediments and uprooting of sea grass due to increased buoyancy under wave action. • Bleaching and death of sea grass. • Decreased density of shoots and growth. • Dispersants increase toxicity of oil to sea grass. • Secondary effects on dugongs: an endangered mammal with a population estimated at ~250 in the Bazaruto area, are closely associated with sea grass beds at depths of <10m. Loss of sea grass habitat will further endanger dugong survival.	Zieman *et al* (1984); Howard *et al* (1989); Thorhaug *et al* (1992, 1998); McInnes & Ralph (2003); Juday & Foster (1990); Dean *et al* (1998).	Bazaruto Archipelago and along mainland coast to Save River Estuary
Rocky Shores	• Toxic exposure of rocky shore fauna and flora (molluscs on rocks, algae, echinoderms etc.) leading to direct mortality from smothering by oil or toxic effects through the respiratory or digestive system of organisms. Toxic effects are worsened through the use of dispersants although recovery period is increased. • Exposed shores recover more quickly than sheltered shores as strong wave action removes contamination and biota of exposed shores are able to more quickly colonise an impacted shore.	Hawkins *et al* (2002); Edgar *et al* (2003); Smith (1968); Brien & Dixon (1976); Chasse (1978); Teal & Howarth (1984); Edgar & Barrett (2000); Kingston (2002); Laffon *et al* (2006); Mariogomez *et al* (2006).	Entire coastline including Sao Sebastiao and Bazaruto

Habitat, Communities or Species	Vulnerability to Oil	References related to oiling	Location in Project Area
Sandy Beaches	• Toxic exposure and smothering of flora and fauna causing direct mortality of species, particularly hydrocarbon sensitive species such as crustaceans (filter-feeders) and amphipods which can rapidly disappear after an oil spill. • Species on high shore beaches often do not have larval dispersion phase and therefore are not quickly recolonised. • Exposed shores recover more quickly than sheltered shores as strong wave action removes oil contamination, and biota of exposed shores are able to more quickly colonise an impacted shore. • Decreased species richness is observed in beaches after oil spills with lower diversity of crustaceans, polychaetes, molluscs and insects, but recovery occurs in the short to medium term.	Sanders *et al* (1980); Elmgren *et al* (1983); Dauvin (1987); Gomez Gesteira *et al* (2000); De la Huz *et al* (2005);	Entire coastline from north of Beira to Vilanculos and including Bazaruto Islands.
Estuaries	• Natural intrusion of sea water into estuaries in winter months can result in ingress of oil entrained in seawater entering these sensitive habitats which are critical nursery areas for fish and prawn recruitment as well as foraging areas for birds, and habitat for unique estuarine crustaceans such as mud crabs. • Oil will enter and increase the concentration of aromatic hydrocarbons and therefore the toxicity of water column with greater effects on aquatic organisms (fish and prawn larvae) than in open sea.		Save River Estuary near Nova Mambone, and Buzi and Pungue Estuaries near Beira

Habitat, Communities or Species	Vulnerability to Oil	References related to oiling	Location in Project Area
Mangroves	• Mangroves are low energy systems with organic fine sediments that trap oil. • Oil causes smothering of mangrove breathing and feeding roots, as well associated fauna, such as crabs. • Oil with lower molecular weight aromatic compounds cause damage to cell membranes in subsurface roots, which impairs the normal salt exclusion process, and stressing the tree through influx of salt. • Oiled mangroves suffer leaf loss, and depending on the extent of oiling, partial to complete defoliation of trees. • Oiling of roots and sediment may result in acute tree death, restricted growth of surviving trees and affect seedling recruitment, and may lead to reduced forest canopy of up to 30 percent. • Recovery depends on the extent of flushing and the residence time and type of oil, but tends to be long term and can take up to 20 years. Areas with high tidal washing recover much quicker. • Worst effects on mangroves seen with deposition of crude oil and diesel, with less damage from fuel oil. • Use of dispersants tends to reduce tree mortality and was thought to enhance the recovery of surviving trees and Sipunculan worms.	Jackson *et al* (1989); Volkman *et al* (1994); Teas *et al* (1989); Burns *et al* (1999); Nadeau & Berquist (1977); Duke & Burns (1999); Duke & Pinzon (1993); Duke *et al* (1997); Garrity *et al* (1994); Mille *et al* (1998); Scherrer & Mille (1989);	

Habitat, Communities or Species	Vulnerability to Oil	References related to oiling	Location in Project Area
Plankton	• Abundance of phytoplankton may increase after an oil spill due to increased nutrient availability, while zooplankton, fish larvae and eggs may suffer increased mortality due to toxicity in the water column. • The effect of an oil spill on plankton is dependent on the structure of the plankton community; the natural environmental conditions eg sea temperature; relationships between plankton types that may conceal contaminant effects. • Conclusive effects of oil spills are difficult due to the natural variability and high turnover of plankton communities. Many studies of oil spills have not demonstrated any major effects on phytoplankton. • Oil spills may however lead to lethal and sub-lethal effects on fish larvae and juveniles, and therefore can affect the food chain of other fish species.	Varela *et al*. (1996, 2006); Michael (1977; Sandborn (1977); Spooner, (1977) Nelson-Smith, (1970), Straughan, (1972); Kuhnhold, (1978), Linden *et al*., (1979); Johansson *et al*., (1980); Collier *et al*., (1996); Hose & Brown (1998); Teal & Howarth (1984); Mignucci-Giannoni (1999); Griswold (1981); Spies *et al*., (1996); Wardrop (1987); Van der Meulen & Singh (1994); Thomas *et al* (1981); Throndsen (1982); Ostgaard *et al* l (1984); Lannergren (1978); Banks (2003); Davenport (1982); Lee *et al* (1978); Scholten *et al* (1987); Vargo *et al* (1982)	Throughout Sofala Bay
Benthic Invertebrates	• Sub-tidal regions generally have lower hydrocarbon concentrations after a spill than inter-tidal regions as often the oil is carried and spread at the sea surface (as would be the case of condensate). • Effects can include rapid mortality of oil sensitive species such as crustaceans and amphipods; a period of reduced species and abundance; and then a period of altered community structure with increased abundance of opportunistic species then a decline as sensitive species start to recolonise the habitat.	Lee & Page (1997); Gestiera & Dauvin (2005); Hawkins *et al* (2002); de la Huz *et al* (2005); Hawkins (2002); Whitfield (2003); Gray *et al* (1990); Kingston *et al* (1995); Hatcher & Larkum (1982); Serrano *et al* (1988)	

Habitat, Communities or Species	Vulnerability to Oil	References related to oiling	Location in Project Area
Fish	• Oil exposure in fish can lead to mortality, or sub-lethal impacts on growth, physiology, behaviour and lowered disease resistance. • Fish are often considered more resistant to oil spills than other groups due to their ability to avoid spill areas, but larvae and juveniles may suffer higher mortality. • Certain species, such as demersal rock fish, that are more territorial may suffer most from habitat pollution. • Longer term impacts of an oil spill have shown genetic damage, physical deformities, reduced abundance and growth, and compromised survival of some life stages. • Oil induced mortality and longer term recruitment studies do not demonstrate a clear link.	Edgar et al (2003); Shelton (1976); Edgar & Barrett (2000); Collier *et al* (1996); Hose & Brown (1998); Teal & Howarth (1984); Griswold (1981); Spies *et al* (1996); Peterson (2001, 2003); Jewett *et al* (1999, 2002); Carls *et al* (2002); Born *et al* (2003); Richardson *et al* (1995).	
Turtles	• Oil can have a toxic impact on turtles through contact and exposure of the skin, lung, gut, sense organs and eggs. • Sub-lethal effects of oil may occur through carcinogenesis (cancer-initiation); increased susceptibility to parasites and diseases, decreased aerobic content and decreased dive times (affecting feeding); organ dysfunction; disturbed hormone balance; and interference with sense organs and abnormal development. • Crude oil spills can lead to negative effects on all physiological systems of sea turtles, including changes in respiration, dive patterns, metabolism, blood chemistry, and salt glands. • Eggs oiled at the beginning of incubation have a decreased survival to hatching and exhibit abnormalities in scutal (plate) development, possibly from oil inhibiting gas exchange in the egg stage. • Other effects of oil at the nesting stage can include oil affecting nest temperature, gas exchange and moisture of the nest. Oil contamination of beaches may limit female's nesting behaviour and could result in reduced egg laying. • Hatchlings are particularly vulnerable to oil due to their lower mobility and the amount of time they spend at the surface where most oil occurs. • Hatchlings and adults ingest tar balls, increasing toxicity exposure. • Exposure to oil in laboratory situation causes skin pathology changes, including sloughing of skin and mucous membranes for a month after oil exposure, and skin biopsies showed acute dermatitis, exposing the animals to increased infection.	Lutcavage *et al* (1995, 1997); Fritts & McGhee (1982); Phillot & Parmenter (2001); Chan & Liew (1988); Brongersma (1968); Witham (1978, 1983 in Chan & Liew 1988); Carr (1987); Loehefener *et al* (1989): Witherington (1994); Hall *et al* (1983); Odell & MacMurray (1986).	Throughout Sofala Bay with nesting on sandy beaches along entire coastline by different species. Known nesting sites not recorded.

Habitat, Communities or Species	Vulnerability to Oil	References related to oiling	Location in Project Area
Pelagic and coastal birds	• Toxic effects of oil on mudflats and intertidal areas would most directly affect water birds through smothering and toxicity to invertebrates on which they feed. • Oiling of birds can increase mortality through smothering of feathers leading to loss of insulation, and disrupting feeding, and causing starvation. • Ingestion of oil from preening or from eating smothered invertebrates, or inhibited inhalation, can cause sub-lethal toxicity and mortality. • Oiling of beach habitat can reduce reproductive success of beach egg laying birds such as oystercatchers. • Diving of pelagic birds can cause oiling of feathers and damage to eyes, plus ingestion of prey items that are oiled. • High mortality is often associated with oil spills, and in the case of the Exxon Valdez spill an estimated 30,000 plus birds of 90 species were collected from polluted area five months later, and total mortality was estimated at 100,000 to 300,000 birds. Recovery of seabird habitat was evident five years later and populations can often recover over time due to their high mobility.	Petersen *et al* (2003); Heubeck *et al* (2003), Kingston (2002); Wiens *et al* (1996); Piatt *et al* (1990); Piatt & Ford (1996); Wiens *et al* (1996).	Throughout study area, but particularly Bazaruto Archipelago with high abundance of water birds

Habitat, Communities or Species	Vulnerability to Oil	References related to oiling	Location in Project Area
Dolphins and Whales	• Elevated polyaromatic hydrocarbon levels can occur in cetaceans, which reflect the higher trophic position of these animals, where PAH are concentrated through the food chain. • Some oil components can irritate skin and mucous membranes of the respiratory and digestive tract due to solubility of cutaneous lipids (fats). Continued contact can cause epidermal necrosis. Other studies suggest cetacean skin is effective against the toxic effects of petroleum and no contact dermatitis has been observed in other studies. Eyes can be sensitive to oil leading to irritation to corneal ulcers to loss of vision with intense long term exposure. • Inhalation of the light volatile fraction of oil can lead to absorption into the circulatory system; mild irritation and even permanent damage to tissues such as sensitive membranes of eyes, mouth and respiratory tract. Release of volatile PAHs such as benzene, toluene, may pose more risk than a thick oil residue as cetaceans inhale the air immediately above the polluted surface, and would be at biggest risk immediately after release. • Baleen whales that rely on filtering of water through baleen plates can suffer impaired water flow in fouled baleen and this effect is directly related to the oil viscosity, and occurs particularly at low water temperatures. However, baleen clears quickly and this may be a short term effect if the animal moves away from the affected area. • Evidence of avoidance of oil slicks by cetaceans is inconclusive although it is often presumed that these species would tend to avoid them.	Marsili *et al* (2001); Walsh *et al* 1974 in Bratton *et al* (1990); Geraci *et al* (1983, 1986, 1988, 1990); Scholtz *et al* (1992); St Aubin (1985, 1990); [Grose & Mattson (1977); Shane & Schmidly (1978); Goodale *et al*. (1981); Gruber (1981); Evans (1983); Owen (1984); Sorensen *et al* (1984) – all in Bratton *et al* 1990]	Throughout Sofala Bay and Bazaruto Area
Dugongs	• Sub-lethal toxicity can arise from direct contact or ingestion, or from respiratory inhalation of volatile compounds or from irritation of the eyes and mouth. • Impacts will be particularly severe on dugongs through oiling of sea grass habitat or destruction of sea grass beds through conglomeration with sediments, followed by sediment destabilisation and wave action.	WWF (2004); No studies of oiling on dugongs are known.	

9.3.7 *Impacts of a Hydrocarbon Spill on Sensitive Habitats and Species*

The area potentially affected by a condensate spill in the study area has been described in *Section 9.3.3*. For a worst case condensate spill from an area near the proposed Delta well site (approximately 23 km from shore), the affected area includes at its maximal extent, the entire area from Machesse to the north of Beira to Divinhe south of Beira. This maximal extent will however mainly comprise a light surface oiling to a thickness of <0.01 mm. The length of affected coastline was estimated to extend from an area south of Machesse to the Buzi Estuary. These areas are highly sensitive and contain extensive mangrove forests, which are productive systems playing a major role in supporting fisheries through providing nursery habitat for fish and prawns.

A blow out at the drilling site Charlie, located 50 km southeast of Delta, or in a similar area, would likely exhibit some similarities in trajectory of a spill in the M-10 Concession, such as that modelled for Bravo (see *Annex E*). Here, the southward current would be expected to push the spill southwards towards Bazaruto, while at the same time tidal influences would push it towards the coast. Therefore a major spill or blowout in most of the deeper, more seaward areas of Sofala would likely affect more of the coastline to the south than a spill at Delta (closer to Beira). In this event, sensitive ecosystems would include the mangrove forests in the southern and central part of Sofala Bay, and the Save River mouth, which is also an important nursery for fish and prawns. It is possible that some surface oiling could reach Bazaruto but this would be expected to be at very low levels and to dissipate quickly through evaporation.

The environmental impact of oil released into the marine environment depends on numerous factors. The chemical composition of the oil and local weather conditions and ocean currents will greatly control the transport and fate of the released petroleum. The volume of oil released and its proximity to sensitive marine ecosystems will greatly influence the resulting environmental impact of the release. The oil spill modelling provides detailed results on the fate of possible spills within the project area (*Section 9.3.3*). Combining the results of the oil spill modelling with knowledge of the sensitive receptors in the project area (described in the baseline Chapter 6 and 7), allows for the assessment of potential impacts. It should be noted that such assessments are based on the likelihoods of impacts once an oil spill has occurred and no probabilities of oil spilling have been incorporated into these assessments.

Habitats and species that may be affected in the unlikely event of a spill in the Sofala Concession could include:

- Estuaries – key estuaries in the broader study area include Govuro River Mouth, Save River Estuary and the Buzi and Pungue River mouths. These estuaries are important nursery areas for fish and prawns and are critical for their ecological role in the prawn fishery (see *Section 6.4.3* and *7.3* on fisheries)

- Mangrove forests – occurs along an extensive coastal area of Sofala Bay from Govuro River Estuary to Buzi River mouth and with some forests in the Pungue River near Beira. Mangroves stabilise the shoreline which is already subject to significant coastal erosion, and are highly productive systems that contribute nutrients for the fishery and other ecological food webs and processes.

- Sandy and rocky beach – along entire coastline

- Turtles – green and loggerhead (endangered), hawksbill and leatherback (critically endangered), and olive-ridley. All occur throughout the project area, where many are caught in fishing nets. Turtles nest between October and February, and hatch from January to April, and therefore the hatchling phase could coincide with the drilling phase.

- Whales and Dolphins – five species of dolphin, five toothed whale species and two baleen whale species are known to occur in the area. All are protected species in Mozambique. None are endangered but are mostly listed as data deficient or of least concern. The hump-back dolphin is near threatened and the sperm whale is vulnerable. Most of these species have been recorded in the Bazaruto area, while spinner dolphin and humpback whale have been recorded in Sofala Bank and others are likely to occur. Baleen whales (Minke and humpback) have been observed in calving season between May and November.

- Intertidal birds (waders) – occur throughout project area but a wide variety and abundance of waders occurs in the Bazaruto Archipelago, a National Park and potential RAMSAR site, which include Greater Flamingos on the extensive beaches.

In the event that a major blow out occurred at the southern part of the Sofala Concession, it is possible that the following sensitive areas and species in the Bazaruto Archipelago area (in addition to the more widespread species and habitats mentioned above) could be affected to some (probably limited) degree:

- Coral reefs – with a diversity of coral communities (and which support the high-value tourism industry in the area – see *Section 7.3.7*).

- Sea grass (dugong) habitat where 88 km² is estimated in shallow inter- and sub-tidal waters extending up to 4,000 from shore. No sea grass habitat is known to occur in Sofala Bay. Sea grass provides habitat for prawns, and it plays an ecological role in stabilising substrate which once disturbed is not easily colonised. It is also the preferred habitat on which the endangered dugongs are largely dependent for feeding.

- Dugongs – are largely restricted to the Bazaruto Archipelago where they are associated with sea grass in water shallower than 8 m. They are long lived; give birth to one calf from the age of 10 years, which suckles for 18 months, and adults have a calving interval of three to five years. This slow rate of population recruitment combined with hunting and habitat pressures has left them listed as Vulnerable to Extinction.

The understood and documented consequences or effects of an oil spill on these habitat types are summarised in *Table 9.6* based on best available information, together with their known distributions in the project area. Information on the distribution of these habitat types and species are provided in Chapter 6.

The impacts of an oil spill on the marine environment has been assessed as one overall impact in *Table 9.7* below for simplicity as the extent of coverage of the potential oil spill trajectory is widespread and would affect a number of these habitats and species components simultaneously. In addition, the impacts on one habitat type may be linked to survival of a component species eg sea grass habitat and dugongs, or estuarine / mangrove impacts on fish.

Table 9.7 Impacts of Oil Spill on Sensitive Marine and Coastal Habitats and Species

Nature of Impact	**A worst case oil spill from a blow out or vessel collision would result in some degree of oiling of sensitive habitats which could impair ecological functioning and increased toxicity effects of component communities, and possibly mortality of some individuals.**
Magnitude	**Magnitude - High** *Extent*: **Regional to International** as Bazaruto (if affected) is a protected area under the International Ramsar Convention and a prime international tourist destination. A major oil spill would require a national level of intervention. ***Duration:*** **Long-term** ***Intensity***: **High** in worst case scenario as marine resources are abundant and support a diverse ecosystem but intensity will depend on type of oil spilled and prevailing environmental conditions at the time of spill.
Likelihood	**Likely** as the impact is likely to occur in the remote event of a well blow out or vessel collision
Significance	**Major**
Degree of confidence	**Moderate to High**

Table 9.8 *Significance: Impact of a Worst Case Oil Spill on Sensitive Marine and Coastal Habitat and Species*

Phase	**Significance with embedded mitigation (excluding clean up intervention)**
Drilling	**MAJOR (-ve)**
Post-Drilling (Residual)	**MODERATE (-ve)**

*Impacts of a major oil spill could be considered moderate for a period of 5-10 years after the event.

9.3.8 Impact of a Worst Case Oil Spill on Tourism and Tourism-Derived Livelihood

A major oil spill, if it was to reach the Bazaruto area, could cause contamination and some degree of oiling of highly prized beaches, coral reefs and resort areas for tourism. Oiling of these would severely detract from, and interfere with, recreational activities such as snorkelling, diving, fishing, bathing, and boating. Lodge, hotel, restaurant owners, tour operators and others who gain their livelihood from the tourist trade could be affected, particularly if a major oil spill were to occur during the peak tourist seasons of April, September and especially December - January.

A spill in the northern part of the Sofala Concession is unlikely to reach Bazaruto but is likely to cause oiling of beaches north and south of Beira, which could detract from the low level of tourism in this area.

The Bazaruto-Vilanculos area is one of the most important tourism regions of Mozambique and is one of Mozambique's priority tourist investment areas. A significant amount of foreign investment in tourism occurred between 2004 and 2008, almost doubling the number of accommodation establishments. In the Vilanculos area, tourism is the largest formal sector employer in the area, creating an estimated 20,000 jobs. Tourism almost exclusively revolves around access and use of the marine environment and any limitation to this could result in a significant impact on a regional scale.

The negative impact on the tourism industry as a result of an oil spill could arise as a direct impact associated with visual and odour impacts, and detraction from bathing, fishing and diving areas. Indirect impacts could occur from pollution of coral reefs and recreational fishing areas. In the event of an oil spill, changing attitudes and perceptions of the area as a pristine area could reduce visitor numbers to the area in the long term. This would impact on accommodation establishments, tour operators, and various employees of goods and services linked to the tourist industry.

A serious oil spill would reduce continued investor confidence in the tourism industry in the area thereby potentially decreasing growth in this industry for a few years. Attitude changes among investors, and hence associated indirect impacts, will likely be different depending on the timing of the spill, the extent and intensity of the spill and the level of success of any clean-up actions.

Table 9.9 Impacts of Worst Case Oil Spill on Tourism and Tourism Livelihoods (if Bazaruto is affected)

Nature of Impact	**Contamination of coastal and marine recreational areas would detract from tourism in the Bazaruto Archipelago, particularly marine-based activities such as bathing, boating, diving, snorkelling and sport fishing. Lodge, hotel, restaurant owners and tour operators, and others who gain their livelihood from the tourist trade could be significantly affected.**
Magnitude	**Magnitude - High** *Extent*: **Regional to International** as Bazaruto is a prime international tourist destination ***Duration:*** **Medium** but depends on success of clean up action and recovery rate. ***Intensity***: **High** especially if oil spill occurs before a peak holiday season.
Likelihood	**Likely** as the impact is likely to occur in the remote event of a well blow out or vessel collision but will depend on where in Sofala Concession the blow out occurred
Significance	**Major**
Degree of confidence	**Moderate**

Note: a major spill in the central to northern part of Sofala Concession is unlikely to reach Bazaruto.

Table 9.10 Significance: Impact of a Worst Case Oil Spill on the Marine and Coastal Environment

Phase	**Significance with embedded mitigation (excluding clean up interventions)**
Drilling	**MAJOR (-ve)**
Post-Drilling (Residual)	**MODERATE (-ve)**

*Impacts of a major oil spill could be considered moderate significance for a period of 5-10 years after the event.

9.3.9 *Impact of a Worst Case Oil Spill on Fishing*

Impact on Artisanal Fishing

An estimated 4,000 artisanal fishers with 1,455 vessels fish the inshore waters near the concession area, while a total of 4,673 vessels and 11,400 permanent fishers are recorded for districts in the broader area around the drilling area that could potentially be affected by a major oil spill. A great many more people in extended families depend for their livelihoods on fishing, either for generation of household income or through fish as a protein source.

Impacts on fishers would occur through direct reduction in fish catches and catch success of other marine organisms (eg in the intertidal zone) due to either enforced bans on fishing due to toxicity/pollution, or lack of access to fishing grounds. A major oil spill could reduce market and buyer confidence in fresh fish products for a period of time until fish in Sofala Bay is declared fit for consumption. Fishermen themselves could also be at risk of potential health impacts from inhalation of volatile polyaromatic compounds if they remain in areas where surface oiling is evaporating.

An oil spill can damage fishing boats and nets and other equipment used by local fishermen. Floating equipment and fixed traps extending above the sea surface are more likely to become contaminated by floating oil whereas submerged nets and traps are usually well protected, provided they are not lifted through an oily sea surface.

In the longer term, besides the direct impacts of an oil spill on fish through mortality or moving away from polluted areas, an oil spill could have serious and deleterious effects on recruitment of fish and prawns through impacts on estuaries and mangroves, which serve as nursery areas. In addition, impacts of an oil spill on plankton, particularly zooplankton, could cause reduced food supplies or sub-lethal impacts on fish higher up the food chain, resulting in longer term impacts on fish production and catch success.

Decreased catch success in inshore coastal waters as a result of a ban on fishing, fish mortality, limited access or fouling of fishing gear, even in the short term, could result in a significant impact on local populations in Sofala Bay due to the vulnerable socio-economic status of these communities, the lack of alternative livelihood opportunities, and limitations of their fishing boats to fish in alternative non-oiled locations. A decrease in catches by artisanal fishermen would not only result in a loss of income and reduction of food security for fisher families but would also affect other activities directly dependent on fisheries. Even if fish were caught, the sale of these fish to third parties may still be negatively impacted as a result of the perception of the fish being tainted.

Table 9.11 Impacts of Worst Case Oil Spill on Artisanal Fishing

Nature of Impact	**Artisanal fishers would be impacted by a reduction in fish catches and collection of other marine organism in the intertidal zone due to likely bans on fishing/collection, and lack of access to fishing grounds after an oil spill. Decrease in marketability of fish, fouling of fishing gear and health impacts as a result of hydrocarbon evaporation could also be experienced.**
Magnitude	**Magnitude - High** *Extent*: **Regional** (major oil spill would affect fisheries of Sofala Bank) ***Duration:*** **Medium** (but depends on success of clean up action and recovery rate) ***Intensity***: **High** (especially if oil spill occurs in peak prawn fishing season (March to May) when 50% of annual catch is caught.
Likelihood	**Likely** (the impact is likely to occur in the remote event of a well blow out or vessel collision)

Nature of Impact	**Artisanal fishers would be impacted by a reduction in fish catches and collection of other marine organism in the intertidal zone due to likely bans on fishing/collection, and lack of access to fishing grounds after an oil spill. Decrease in marketability of fish, fouling of fishing gear and health impacts as a result of hydrocarbon evaporation could also be experienced.**
Significance	**Major** (given the high dependence of local residents on fishing for livelihoods as an income and protein source, and the lack of other alternatives, a major oil spill would be of very high significance to artisanal fishers and their families).
Degree of confidence	**Moderate**

Table 9.12 Significance: Impact of a Worst Case Oil Spill on Artisanal Fishing

Phase	Significance with embedded mitigation (excluding clean up interventions)
Drilling	**MAJOR (-ve)**
Post-Drilling (Residual)	**MODERATE (-ve)**

*Impacts of a major oil spill on fisheries would likely be considered minor significance for a period of three to five years after the event.

Impact on Industrial Fishing

The Sofala Bank is Mozambique's primary fishing zone and supports the main commercial penaeid prawn fishery valued at 80 million dollars in exports in recent years, equivalent to three percent of GDP (Ministry of Fisheries, 2008). The industrial fishing fleet involves around over 300 vessels, based on data for vessels operating out of Beira, of which 58 industrial vessels are used for commercial fishing of shallow water shrimps in waters less than 25 m deep. Peak prawn fishing season is March to May, during which time over 50 percent of the annual prawn catch is caught. A further 16 industrial vessels are used for deep water prawn fishing and 18 for line fishing.

A worst case scenario for the modelled oil spill of condensate or heavy fuel could result in wide-scale surface oiling across Sofala Bay extending from around Machesse, north of Beira, south to the Save River Estuary and possibly beyond. This would encompass the entire shallow water prawn fishery to the west of the concession. If a major spill was to occur in the north of the concession, the highest probability of surface oiling would extend from the well site towards Beira and adjacent coastlines and estuaries, which are highly important area in the lifecycle of the prawns and which supports the high value fishery of Sofala Bank. A serious oil spill reaching this area can be expected to have highly significant consequences for the prawn fishery, as well as other fish species which depend on spawning or growth of juveniles in estuaries. It would also affect the clam-based fishery in the inshore areas around Beira.

The impacts of a major oil spill on industrial fishing could arise from direct mortality of target species; imposition of a ban on fish catches and a ban on consumption for toxic reasons; reduced marketability due to perceived or real pollution risks; and fouling of fishing gear.

The extent and duration of the impact will depend on prevailing environmental conditions, the type and amount of fuel spilled, and the timing and success of any clean up measures.

Table 9.13 Impacts of Worst Case Oil Spill on Industrial Fishing

Nature of Impact	**The impact of a major oil spill on the Sofala Bank would have serious consequences**
Magnitude	**Magnitude – High** *Extent*: **Regional to International** as a major oil spill would affect fisheries of Sofala Bank, a major source of export revenues for Mozambique. ***Duration:*** **Medium** but depends on success of clean up action and recovery rate. ***Intensity***: **High** especially if oil spill occurs in peak prawn fishing season (March to May) when 50% of annual catch is caught but will depend on type of oil.
Probability	**Likely** (the impact is likely to occur in the remote event of a well blow out or vessel collision)
Significance	**Major**
Degree of confidence	**Moderate**

Table 9.14 Significance: Impact of a Worst Case Oil Spill on Industrial Fishing

Phase	**Significance with embedded mitigation (excluding clean-up measures)**
Drilling	**MAJOR (-ve)**
Post-Drilling (Residual)	**MODERATE (-ve)**

*Residual impacts of a major oil spill on industrial fishing could be considered to be of moderate significance for a period of three to five years after the event.

9.3.10 *Mitigation of an Oil Spill*

Mitigation measures range from measures that are intrinsic to the technological safety equipment and procedures and which are undertaken as a matter of course by international drilling contractors ('embedded mitigation'), and additional mitigation measures, which can be considered as extra preventive or amelioration measures. The latter would include the development and testing of an emergency response plan *with* other key stakeholders in the project area ('additional mitigation').

From the modelling results, the minimum time of water surface oiling after the occurrence of a spill would be very short (<24 hours to landfall) for the spill scenario arising from the Delta well site in Sofala Concession. The spill scenario arising from the Charlie well site is likely to have a minimum water surface oiling time of <48 hours as it is 50 km further from land than Delta. Under this scenario, there will be relatively little time to execute the oil spill response plan before oil may reach sensitive areas along the coast. Furthermore, the potentially strong tidal flows suggest that the spills may be difficult to contain (eg by booming) and that the sensitive ecology of the region (eg mangroves, estuaries, and sea grass) suggests a need to judiciously examine the use of dispersants, if at all. Naturally, the priority will be to implement all possible precautionary measures to ensure the chance of a spill or blow out is maintained at the lowest risk level. This means that all precautionary measures should be adopted to reduce the possibility of a spill to almost non-existent.

The main risk sources for significant oil spills include vessel collisions, uncontrolled well blow-outs and spillages during refuelling. Various standard oil industry measures will be implemented to minimise the risk of an oil spill from occurring. A number of the key precautionary measures are discussed below:

Blow-out Prevention Equipment

A safeguard against an uncontrolled release of hydrocarbons during drilling is the use of Blow Out Prevention Equipment (BOP), a specialised piece of safety equipment used to reduce the likelihood of a blow-out occurring. A BOP is installed on top of the well bore, and is designed to close the well in the event of an emergency. This equipment will be thoroughly inspected prior to installation and subsequently pressure and function tested on a regular basis in accordance with oil industry recommended practices.

Refuelling

Spillage of fuel oil can occur through a malfunction or failure during refuelling operations at sea. The likelihood of such events will be minimised by conducting refuelling operations in calm weather conditions and rigorous monitoring of the refuelling operations. Pre-booming is also recommended to be undertaken during any refuelling operation at sea.

Good Communication with other marine users

Other marine users should be notified prior to the commencement of the operation. Through normal maritime communication channels, stakeholders should be kept informed throughout the drilling operations as to the location of exclusion and safety zones around the drilling rig and the timing of activities. By keeping other marine users informed, potential emergency situations can be prevented.

In addition, collision prevention equipment, including radar, multi-frequency radio, foghorns and lights should be used. Additional measures include 24-hour watches, maintaining the internationally agreed 500 m exclusion zone around the drilling rig, cautionary notices to mariners, presence of a support vessel, and access to current weather service information.

Combating Oil Spills

Sasol will prepare an Oil Spill Response Plan for drilling in accordance with IPIECA (1993), which will detail the manner in which spills of different sizes and types will be handled, including the use of equipment and dispersants. The plan should include an analysis and an inventory of available and lacking equipment. The plan should be compiled with the input and knowledge of the Maritime Authority, Port authorities and Fisheries Industry stakeholders to ensure all institutions are informed and are aware of their roles and responsibilities in the event of a disaster. Consideration should be given to conducting an implementation exercise of this plan.

Options for handling oil spills that will be addressed in the Response Plan include containment and recovery and/or dispersion via natural means.

The plan will detail the implementation steps, communication channels, and organisations to be involved and their roles. It will be designed for immediate implementation should a spill arise.

In the event of an oil pollution incident, Sasol's strategy will be to:
- limit the volume of the spill at source;
- assess the fate of the spill;
- contain/recover oil when it threatens coastal/marine resources at sea; and
- clean up areas where oil does come ashore.

Should an oil spill threaten to reach the coast the most realistic option is to combat the spill at sea. If the sea state permits, booms and skimmers should be deployed.

Strenuous efforts should be made to prevent oil from entering the coastal lagoons and the estuaries. Whenever possible the spilled oil should be recovered at sea as close to the source as possible. Should the sea state prevent mechanical recovery, the use of dispersants could be considered depending on the environment affected and where their use may be required. However, they are often not recommended for use in sensitive shallow water environments due to their chemical toxicity. The international debate on use of dispersants is ongoing as they are often considered to cause more harm than good in coastal environments (see below).

If oil enters mangroves, the main clean-up options are (IPIECA, 1993):

- booming and skimming of oil on the water surface in mangrove creeks;
- pumping of bulk oil from the sediment surface, depressions and channels;
- water flushing of free oil from sediment surface and mangroves, into areas where it may be collected; and
- use of absorbent materials, with subsequent collection and disposal.

Overview of Dispersants

Dispersants combat oil spills by breaking oil slicks into tiny droplets which become suspended in the water column. Once suspended in the water column, the tiny droplets can be degraded more readily, and as the oil slick is broken up, the chances of shoreline fouling are diminished.

Dispersants were first used in the Torrey Canyon spill in 1967. Since then, modern dispersants have been developed which are environmentally safer (ie less toxic) than the earlier formulations. The benefits of dispersant application need to be weighed against possible risks. Dispersants can be effective in breaking up oil slicks, thereby reducing the chance of shoreline fouling, through enhancing degradation and weathering of oil. However, in shallow areas dispersants can increase the exposure of organisms and habitats to dissolved hydrocarbons, possibly resulting in greater environmental effects.

Subsection 3.4 of the Mozambique National Oil Spill Contingency Plan (NOSCP) (Plano Nacional de Contingência o Combate a Poluição Maratima) (1) describes the procedures to combat marine pollution, with consideration to the environmental legislation applicable to Mozambican water. The use of mechanical techniques is recommended for oil spill recovery and containment. On the open ocean, mechanical recovery and containment methods are often limited by the sea state. Consequently, when rough conditions prevent deployment of booms and skimmers, the use of dispersant chemicals to prevent the oiling of sensitive shorelines or other valuable habitats is often the only option. It should, however, be noted that, according to NOSCP, the use of dispersants is prohibited in areas from the coast out to the 100 m isobath. Also, dispersants may not be used where potable water sources could be affected, which is the case along the coastline between Inhassoro and the Govuro River mouth where coastal communities access fresh water springs above the high water mark at the base of the cliffs.

9.3.11 *Summary of Potential Oil Spill Impacts*

It should be noted that all impacts have been assessed assuming that an oil spill has occurred, and therefore the probability refers to the likelihood of the

(1) Note that the Mozambique NOSCP is currently in draft format.

impact arising in the event of a major oil spill. The rating has no link to the probability of the oil spill occurring.

The significance of oil spill impact ratings impacts have not been assessed with mitigation due to the questionable effectiveness of oil spill mitigation under upset environmental conditions.

Overall, a major oil spill arising from well drilling would have a major impact on the marine and coastal environment, and associated fisheries and tourism. The impact would be more severe if it occurs during peak prawn fishing season (March to June) or tourist season (June, September, December to January).

9.3.12 *Conclusion*

The overall significance of the impacts of an oil spill is difficult to predict because of the many variables involved. While the probability of an oil spill is extremely low, should an oil spill occur as per the worst case scenarios, the extent of the impact could be experienced as far north as Machesse and as far south beyond Ponta Sao Sebastiao. The intensity of the impact will depend on the type, volume and location of oil spilled and the dispersion of the oil at the time of the spill. Under the worst case scenarios, sensitive marine and coastal habitats as well as marine animals will be impacted, threatening the integrity of the marine and coastal environment of the BANP and surrounds.

Limited response options are available should an oil spill occur. The application of dispersants is not permitted in terms of the Mozambican National Oil Spill Contingency Plan (NOSCP) in water depths above the 100 m isobath leaving mechanical recovery as the only feasibly option should the sea state allow. The focus would therefore be on ensuring precautionary measures are adopted to the extent that the likelihood of spills becomes almost non-existent.

It must be noted that the risks associated with a vessel collision during drilling present a similar risk of an oil spills posed by any fishing or other vessels operating in Sofala Bay. The significant additional risk that exploration drilling would bring to the area are of a potential blow-out scenario, which has an extremely low probability of occurrence (1 in 25,000 for any drilling programme).

While the probability of an oil spill is very low, should a spill occur, the direct impact on the marine environment and the fishing industry in particular could be significant. Impacts resulting from normal exploration drilling activities are representative of the potential impacts that may occur should viable hydrocarbon reserves be found and exploitation of the reserves approved.

In the light of the potential consequences of an accident occurring in the Sofala Bay and affecting the Bazaruto area, the Mozambican Authorities need to consider the acceptability of the risks associated with exploration drilling and gas/condensate production for future oil and gas activities off the coast of Mozambique. This is a strategic issue which revolves around the long term compatibility of the oil and gas sector with the status of the surrounding natural environment and other economic sectors (tourism and fishing) that are dependent on the natural environment. The Government will have to weigh up the tradeoffs between accepting a potential oil spill risk and the associated impacts against the potential to generate significant revenues from hydrocarbon production for Mozambique.

Section 5

Environmental Management Plan

Chapter 10: EMP for Exploration Drilling

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SECTION 5: CONTENTS

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10 ENVIRONMENTAL MANAGEMENT PLAN

10.1 INTRODUCTION

A key output of the EIA process for the proposed exploration activities is the compilation of an Environmental Management Plan (EMP) for exploration well drilling and testing activities. This section constitutes the EMP, although other more detailed plans have been identified in the EMP and will need to be developed to address more specific management requirements. The EMP outlines the mitigation measures required to avoid or minimise the environmental impacts identified in this report, and is a key document for compliance by the drilling contractor and Sasol to ensure commitment to environmental protection throughout the exploration drilling phase.

10.2 SCOPE OF THE EMP

This EMP covers exploration drilling and well testing activities in the concession area as delimited by a distance of 10 km east of the boundary of the semi-industrial prawn fishing zone defined as the 35°11'E longitude line, and 10 km west of the deep water prawn fishery. The defined 10 km buffer has been determined based on the anticipated dispersion area of the turbidity plume, which is predicted to disperse and reach ambient turbidity levels within 10 km from the drilling site. Should further seismic analysis lead to a shift in the proposed drilling location/s into or beyond the 10 km buffer zone, additional investigations may be required to confirm the impacts and the additional mitigation measures that may be needed to ameliorate fishing impacts. The Terms of Reference for this additional work should be approved by MICOA and the outputs will form an addendum to the original EIA. Additional discussions with the fishing stakeholders may also be required.

10.3 GENERAL CONSIDERATIONS

The project description, provided in Chapter 4, has incorporated many of the measures required to ensure environmental protection and impact minimisation as part of standard operations and in accordance with international best practice and legal requirements. This EMP specifies these best practice and legally-required mitigation measures as a framework for environmental protection throughout the drilling operations. Relevant provisions of the IFC guidelines for the offshore oil and gas industry have been incorporated where appropriate or modified where technology is not readily available or able to meet specifications. For example, the oil content of drill cuttings is specified as five percent, which is the currently accepted standard for using NADF drilling fluids, rather than the IFC specified one percent level as this is not readily achievable with available cuttings cleaning technology.

The EMP will be supplemented with additional subsidiary plans, which are in the process of being prepared by SPSL and with regulatory input and consultation. These will be submitted to MICOA for approval prior to the commencement of drilling.

10.4 *REVISIONS TO THIS EMP*

EMP specifications are designed to achieve optimal environmental protection based on best practice. However, situations can arise where technical difficulties are encountered which prevent the EMP specified standards being met. In these situations, a pragmatic approach is required that allows for some flexibility to determine the best way of meeting the original intent and purpose of the specified measure to ensure that the required intervention satisfies the objective of the mitigation measure.

The EMP is considered to be a "living" document that must be sufficiently flexible and implementable using available and "reasonable" technical capabilities without compromising environmental protection, including socioeconomic aspects (eg fishing and other marine user requirements). In cases, where specific conditions of the EMP cannot be met and there are reasonable technical grounds for modifying the stipulated conditions, any amendments will require approval by MICOA

10.5 *PURPOSE OF THE EMP*

The EMP is required to:

- ensure continuing compliance with Mozambican legislation and Sasol policy and international best practices;

- provide the initial mechanism for ensuring that measures identified in the EIA to mitigate potentially adverse impacts are implemented;

- provide a framework for mitigating impacts that may be unforeseen or unidentified until survey activity is underway;

- provide assurance to regulators and stakeholders that their requirements with respect to environmental and social performance will be met;

- undertake monitoring to provide assurance that the conclusions of the EIA are valid; and

- provide a framework for compliance auditing and inspection to assure Sasol and the regulatory authorities that the identified measures with respect to environmental performance are being met and EIA commitments are implemented in full.

In addition, the EMP serves as a set of contractual clauses and specifications that define the Contractors' environmental responsibilities at the tendering stage.

10.6 CONTENT OF THE EMP

The EMP consists of:

- a register of environmental commitments identified during the EIA;
- a listing of subsidiary plans required prior to drilling; and
- a description of legal and other requirements (standards) based on legal provisions provided in Chapter 3 and Annex C.

10.6.1 *EIA Commitments*

The EMP represents a framework for implementation of the findings and mitigation measures identified during the EIA in order to minimise environmental impacts and to operate in accordance with industry best practice. The EMP sets out the following in tabular format:

- a comprehensive listing of the mitigation measures (actions) that Sasol and its drilling contractor will implement according to phase and activity of the drilling project to ensure the objectives of mitigation are fully met;

- designation of responsibility for ensuring implementation of all EMP requirements;

- the timing for implementation and monitoring of the action; and

- identification of legal and/or other requirements (standards/international conventions for specific mitigation measures).

These commitments are set out in *Section 10.10* and will be further addressed as planning of the drilling activities proceeds and detailed operational requirements are developed. At the same time, the timing and specific responsibilities for implementing each commitment will be agreed between Sasol and the Contractors. Although modifications and fine-tuning of some of these measures are envisaged, there will be one overriding principle: none of the operational tasks or management requirements identified in the EIA will be omitted or diluted without further assessment and reporting of the potential environmental implications to the relevant Environmental Authorities, where necessary.

10.6.2 *Standards*

Environmental issues relevant to all aspects of the proposed exploration activities are governed or guided by a number of 'standards'. These are:

- those contained in Mozambican legislation (see Section 1, Chapter 3);
- those required to meet Sasol's Safety, Health and Environmental policy (*Section 3.5*);
- those established by industry codes of practice (e.g. International Association of Drilling Contractors (IADC), International Association of Geophysical Contractors (IAGC), International Petroleum Industry Environmental Conservation Association (IPIECA), Joint Nature Conservation Committee (JNCC), or International Association for Oil and Gas Producers (OGP);
- relevant international standards and conventions (e.g. World Bank/IFC environmental standards, MARPOL - Prevention of Pollution from Ships 73/78); and
- commitments made in the EIR.

10.6.3 *Subsidiary Plans*

The EMP specifies the additional plans that need to be developed for the management of issues. These include:

- a communications plan;
- a compensation plan;
- a waste management plan;
- an oil spill contingency plan; and
- an emergency response plan (for events such as cyclones etc).

These will be submitted to MICOA for approval prior to drilling.

10.6.4 *Monitoring*

In terms of regulations under the Petroleum Law No. 3 of 2001 and the Environmental Act No. 20 of 1997, monitoring is required to monitor the effects/ impacts of an activity on the environment, and the amount of operational and accidental discharges, leakages and waste shall be reported to the National Petroleum Institute and may be made public. Environmental inspections of environmental monitoring may be carried out by MICOA to verify implementation of the recommendations of environmental audits and the EMP.

The key objectives of monitoring are to:
- provide assurance that the EMP is being implemented;

- to check if compliance standards are being met and if additional measures are required to achieve compliance; and
- to provide feedback to stakeholders and permitting authorities, as may be required.

Monitoring should include aspects and activities, such as:

- Oil content in drill cuttings;
- Volume of drill cuttings;
- Volume of NADF and WBDF used;
- Estimated emissions from flaring;
- Quantities of different wastes generated, used and disposed, including hazardous waste;
- Standard onboard discharges comply with MARPOL standards, such as sewage and deck drainage;
- Incidents of accidental spills and health and safety events eg, near misses or collisions with other vessels or marine fauna; and
- Seabed surveys before and after drilling.

10.7 *ROLES AND RESPONSIBILITIES*

10.7.1 *Sasol's Role*

Sasol, as the overall responsible entity for all Safety, Health and Environmental (SHE) matters, will ensure that all contractors and drilling and well-testing operators are carried out safely and in accordance with the Sasol Safety, Health and Environmental (SHE) Policy (see *Section 3.5*) and with the EMP. Sasol will take overall responsibility for ensuring that the EMP and other SHE related requirements are implemented in full.

Relevant details regarding the exploration well drilling and testing programme will be submitted to the Regulatory Authority (National Petroleum Institute) well in advance of the operations, for their approval.

During drilling and well testing operations, Sasol and/or the drilling contractor will be responsible for the management of medical and health issues and the provision of appropriate care. Sasol / drilling contractor will ensure there are sufficient plans and resources in place for worker health care and contingency plans to respond to workplace accidents.

As part of their operating and SHE procedures, Sasol will undertake regular environmental, social, safety and health inspections and provide reports that enable Sasol to monitor and evaluate performance against the measures and objectives established in the EIA and EMP.

A pre-operational start-up induction for the drilling operation will be conducted by Sasol with their contractors, prior to commencement of operations.

10.7.2 *The Contractors' Role*

Sasol will ensure through diligent contractor selection and management that all contractors comply with the requirements of the EMP during operations, where the provisions are relevant to the contractor's role and responsibilities.

The successful contractor will be appointed in line with Sasol's contracting strategy. The drilling contractor will be affiliated with the International Association for Drilling Contractors (IADC).

As part of the contractor selection process, the successful contractors will need to demonstrate to Sasol's satisfaction how compliance with the requirements of the EMP will be ensured prior to project mobilisation. The successful contractors will also be expected to demonstrate commitment to the EMP at all levels in their own management structure. All successful contractors will be required to identify individuals responsible for overall environment, safety and health matters during the operations.

The successful contractors will be responsible for the relevant training of their staff and to ensure they are fully qualified, sufficiently experienced and certified in accordance with Sasol's contractual requirements for the work they are contracted to conduct.

10.7.3 *Roles and Responsibilities of the Regulatory Agencies*

The regulatory agencies directly concerned with the project include the National Petroleum Institute (INP), the Ministry for the Coordination of Environmental Affairs (MICOA), the Centre for Sustainable Coastal Development (CDS-ZC), the Ministry of Tourism, the National Hydrographic Agency (INAHINA) and the Navy Institute (INAMAR), the Maritime Security Agency (Autoridade Marítima Nacional), Ports Authority (CFM - Caminhos de Ferro de Moçambique), the Mozambique National Aviation Institute (IACM), the Small Scale Fisheries Development Institute (IDPPE), and the Fisheries Research Institute (IIP). The roles and responsibilities of these organisations are as follows:

- INP is primarily responsible for managing the petroleum resources of Mozambique and for the administration of the related operations, in compliance with the existing laws, government policies and contractual commitments. It has the responsibility to perform petroleum resource assessments prior to licensing and during exploration, development and production. It is responsible for monitoring and auditing the operations and to ensure that the Operator's (Sasol's) systems and procedures are adequate for adherence to the goals and standards set out in the legislation, regulations, guidelines and agreements with the operators.

- MICOA is responsible for issuing an environmental license for the project based on the EIA process and for monitoring the environmental performance of projects in the Exclusive Economic Zone (EEZ) of Mozambique. It is also responsible for verifications, inspection and audit before, during and after projects implementation (according to Decree 45/2004). MICOA is also the Governmental Agency responsible for waste handling and management, emissions and sewage management.

- The Ministry of Tourism is responsible for the management of conservation areas, promoting tourist developments and licensing their activities.

- The centre for sustainable coastal development promotes sustainable coastal planning, along with other Agencies and Departments, assisting in monitoring actions of marine resources and coastal biodiversity. It is also the Coordinator of the National Reef Management Programme.

- The National Hydrographic Agency (INAHINA) is the Governmental Agency responsible for Navigational warnings, regarding vessel movements and ship security (according to Law No 4/96). The warnings are made through radio and fax.

- The National Maritime Institute (INAMAR) regulates Navy activities in general and also possible environmental damages created by ships, vessels and sea platforms, based on International Conventions' parameters and guidelines. It establishes measures to control, fight and reduce pollution from ships (according to Law No 4/96) and to handle the finding of shipwrecks. It is also responsible for warnings regarding ship and vessel movement.

- The Maritime Security Agency is responsible for the protection of the marine environment. It is the Government Agency responsible for preventing and fighting marine pollution over the National territory under its jurisdiction, according to Decree No 32/2004.

- The Mozambican National Aviation Institute (IACM) administers helicopters use and issues permits. An operator must obtain a permit from IACM to bring or operate a helicopter in Mozambique. To obtain a permit the following information is required to be submitted at least 48 hours in advance of helicopter operations: name and address of operator, type of helicopter, colour, registration number, name of pilot, number of seats/passengers and purpose of flights.

- The Small Scale Fisheries Development Institute (IDPPE) is responsible for promoting practices which encourage the development of small scale fisheries, helping to improve the livelihoods and working conditions of fishing communities and increasing the level of national protein-rich products.

- The Fisheries Research Institute (IIP) supervises data collection and conducts most of the research and studies on artisanal fisheries.

- The Ports Authority (CFM) is responsible for managing Ports in general, and especially Maputo and Beira Ports. It has a fair control over vessels circulation between both Ports.

Sasol , and where applicable, the successful contractor will be responsible for all relevant clearances, permits, licences and necessary approvals from these bodies prior to commencing the drilling operations.

10.8 IMPLEMENTATION

10.8.1 Introduction

The EMP will be implemented throughout the proposed exploration planning and operational activities. Details of actions required for the implementation of mitigation measures have been tabulated in the form of an action plan. The plan will indicate the organisation responsible for taking specific action and sets out parameters for monitoring the implementation of such action. EMP implementation will be the responsibility of Sasol, while the Regulatory Authorities such as MICOA and the National Petroleum Institute will monitor and undertake compliance audits.

10.8.2 Coordination with Relevant Agencies

Sasol will ensure that coordination is maintained with all relevant agencies described in *Section 10.7.3* dealing with environmental control throughout the projects.

10.8.3 Monitoring

The successful drilling contractor will be responsible for undertaking overboard discharge monitoring, and checking all prescribed parameters and associated limits. Valid calibration certificates for processing units must be available for all monitoring equipment.

10.8.4 *Emergency Procedures*

In the event of an accident or incident, Sasol will report the details to the relevant authorities and key stakeholders who may be affected or need to be involved, as defined in the Oil Spill Contingency and Emergency Response Plans. Sasol will have designated persons responsible for communications with the concerned agencies.

10.8.5 *Training*

The drilling contractor will be responsible for the training, education and reinforcement of all personnel on board the drilling vessel on emergency procedures and implementation of the EMP requirements.

10.9 *CHECKING AND FEEDBACK*

Regular checks and audits will be undertaken by Sasol, who will be responsible for monitoring, surveillance and decision-making on all operational SHE matters. In addition to assessing operational aspects and monitoring, the checks will assess compliance with agreed objectives and targets, and the effectiveness of the EMP and its implementation. The EMP will therefore be subject to ongoing review and development to ensure that it remains appropriate to all aspects of the drilling and well testing project.

All findings will be reviewed by the relevant project teams and where corrective actions are deemed necessary, specific actions (with designated responsibility and timing) will be developed and will be aimed at achieving continuous improvement in performance.

10.10 EXPLORATION WELL DRILLING AND TESTING EMP

Activity		Objective	Actions to be Undertaken to Mitigate Environmental Impact		Responsibility	Frequency / Timing	Key Legislation /Standard
#	Description of Activity		#	Commitment / Actions Required / Key Controls			
PLANNING PHASE							
1.	Pre-operation planning	Develop subsidiary plans	1.1	The following plans must be developed prior to commencing drilling activities: • Communications Plan; • Compensation Plan; • Waste Management Plan; • Emergency Response Plan; and • Oil Spill Contingency Plan. The plans must be submitted and approved by MICOA and / or INP prior to commencement of drilling.	Sasol	Prior to commencement of operation	Petroleum Operations Regulations 24/2004
		Notification of key stakeholders	1.2	In compliance with the Communications Plan, communicate with key stakeholders regarding the timing of operations and the location of the exclusion areas around the drilling vessel.	Sasol	Prior to commencement of operation	-
		Compliance with legal requirements	1.3	Confirm drilling schedule and details, including well locations, details of the drilling programme and support vessels, and drilling fluid and chemicals to be used, and present this information to the National Petroleum Institute (INP).	Sasol	Five weeks prior to the commencement of operations.	Petroleum Law (Law No. 3/2001)
		Preparation for an emergency that could result in an environmental impact.	1.4	Ensure that the following emergency plans, equipment and personnel are in place to deal with all emergencies (including appropriate support): • Oil Spill Contingency Plan; and • Emergency Response Plan (eg, cyclones). Adhere to requirements of the Petroleum Operations Regulations regarding the content of the Oil Spill Contingency Plan. The contingency and response plans must be compiled with the input and cooperation of other stakeholders, the selected drilling contractor, involved in an emergency event and must be aligned with Mozambique's National Oil Spill Contingency Plan. A supply vessel must be in attendance at all times during the operation.	Sasol	Prior to the commencement of operations	Petroleum Operations Regulations 24/2004

Activity		Objective	Actions to be Undertaken to Mitigate Environmental Impact		Responsibility	Frequency / Timing	Key Legislation /Standard
#	Description of Activity		#	Commitment / Actions Required / Key Controls			
		Appointment of a Contractor experienced in drilling to high international best practice.	1.5	The Drilling Contractor will be registered with the International Association for Drilling Contractors (IADC).	Sasol	Prior to the commencement of operations	IADC Code of Practice
		Agreement to comply with EMP and Subsidiary Plans, and Sasol Code of Conduct	1.6	Preferred or short-listed Drilling Contractors must: • provide copies of their procedures covering all aspects of environmental compliance and must agree in writing to comply with this EMP and the other subsidiary plans listed in 1.1. • have a Code of Conduct and agree to abide by its provisions. • demonstrate that they have a comprehensive environmental and awareness training protocol and programme for implementation throughout drilling, and • undertake appropriate preventative measures to reduce the risks of HIV/AIDS and STD transmission by its staff through awareness training and provision of condoms.	Sasol and Drilling Contractor	Prior to awarding contract to drilling contractor	
		Handle waste appropriately	1.7	The Waste Management Plan for the drilling phase should include clarification of handling, storage and disposal of the following waste types: • Solid waste/ garbage (plastics, tins, glass); • Hazardous waste (batteries, spent fuel, fluorescent lights, other chemicals, etc); • Sewage and galley waste; • Radioactive (NORM), if any.	Sasol	Prior to the commencement of operations	MARPOL standards International Finance Corporation (IFC) (2007) Offshore oil and gas development HSE Guidelines
		Avoid impacts on sensitive marine habitats.	1.7	Undertake side scan sonar surveys of seabed conditions in and around the rig site to confirm the absence of sensitive marine habitat and to check for reefs and shipwrecks.	Sasol	Prior to commencement of operation	-

Activity #	Description of Activity	Objective	Actions #	Commitment / Actions Required / Key Controls	Responsibility	Frequency / Timing	Key Legislation /Standard
		Minimise impact on marine environment.	1.8	• As agreed by Sasol, use a low toxicity Water Based Drilling Fluid and a low toxicity Group III Non-Aqueous Drilling Fluid. • Ensure that drilling fluid composition complies with industry standards and submit composition and toxicity details to relevant authorities for approval. • Planning for drill cutting treatment and discharge should comply with industry standards as far as possible, and should have an oil content target not exceeding 5 % by weight on dried cuttings.	Sasol	Prior to the commencement of operations	Industry standards
		Schedule drilling to avoid peak cyclone season	1.9	Where possible based on drilling rig availability, scheduling of drilling activities should prioritise drilling outside of peak prawn fishing season (March to May)	Sasol	Prior to the commencement of operations	-
RIG ESTABLISHMENT PHASE							
2.	Compliance with EMP	Sasol and its Contractors to commit to adhere to EMP.	2.1	Ensure that the approved EMP is incorporated into contract documentation with the drilling contractor and is available on the drilling and supply vessels.	Sasol	Prior to drilling	-
			2.2	Inform support vessel and helicopter crews of EMP requirements and individual responsibilities.	Sasol	Prior to drilling	-
			2.3	Ensure all required equipment is in place to meet EMP requirements.	Sasol	Prior to drilling	-
3.	Notifying other marine users	Ensure that other marine users are aware of the forthcoming drilling operation.	3.1	Inform key stakeholders of the commencement of the drilling operations and drilling location and activities in accordance with Sasol's Communications Plan.	Sasol	30-days in advance of drilling	-
			3.2	Issue Radio Navigational Warnings and Notices to Mariners through the National Hydrographic Office (INAHINA) at least two days in advance of drilling.	Sasol	Two days before drilling vessel is moved to drilling location	Convention on the International Maritime Satellite Organisation (INMARSAT)

Activity		Objective	Actions to be Undertaken to Mitigate Environmental Impact		Responsibility	Frequency / Timing	Key Legislation /Standard
#	Description of Activity		#	Commitment / Actions Required / Key Controls			
4.	Ensure integrity of rig mooring and anchoring system	Reduce environmental risk by minimizing risk of failures during operation.	4.1	The following will be undertaken and/or will be in place in order to minimize environmental risk to as low as reasonably practical: • A hazard identification and risk assessment document; • Operations will be conducted to apply relevant national codes and standards in accordance with good oilfield practice; • The Drilling Contractor will operate in accordance with procedures laid down in the drilling vessel's marine operations manual as approved by the relevant classification society; • All anchor chains and anchors will be certified; and • The drilling vessel will be maintained to class standard throughout the operation.	Sasol	Prior and during drilling	-
OPERATIONAL PHASE							
5.	Navigational warnings	Avoid navigational hazards and maintain good relations with other marine stakeholders	5.1	Continue to keep other users of the sea and key stakeholders informed of drilling activities, vessel movement and drilling schedule, and location by means of Radio Navigational Warnings and Notices to Mariners and regular feedback to relevant authorities.	Sasol	Throughout the operation	Convention on the International Maritime Satellite Organisation (INMARSAT)
			5.2	Keep constant watch for approaching vessels during operations and warn via radio and supply vessel if required.	Sasol	Throughout the operation	-
6.	Maintenance of exclusion zone for safety reasons	To keep other marine users informed of the drilling activities.	6.1	Use effective communication channels to inform key stakeholders about the location, timing, priority of passage, size of safety exclusion zone (500 m from the edge of the drilling vessel). To avoid any interference with anchor and chain it is suggested that the Notice to Mariners advises a stay-clear-area of 1,500 m from the corners of the drilling vessel.	Sasol	Throughout operation	-
7.	Emergency / collision prevention	Minimise risk of environmental and social impacts by implementing preventative and response procedures.	7.1	Ensure that the drilling vessel displays correct signals by day and lights by night, follows visual radar watch, and has a chase vessel to prevent collisions.	Sasol	Throughout the operation	• Oil Preparedness, Response and Co-operation Convention (OPRC) • Convention on the
			7.2	A supply vessel will be used to warn other vessels approaching the 500 m IMO exclusion zone around the drilling vessel that will be maintained at all times.	Sasol	Throughout the operation	

Activity #	Description of Activity	Objective	#	Actions to be Undertaken to Mitigate Environmental Impact: Commitment / Actions Required / Key Controls	Responsibility	Frequency / Timing	Key Legislation /Standard
			7.3	Tier 1 oil spill response capability will be maintained at all times on the drilling vessel.	Sasol	Throughout the operation	International Maritime Satellite Organisation (INMARSAT) • United Nations Law of the Sea Convention (UNCLOS)
			7.4	Implement the Oil Spill Contingency Plan in the event of an oil spill.	Sasol	In the event of an oil spill	
			7.5	Blow Out Preventors (BOPs) on the drilling vessel are to be fully inspected in accordance with the American Petroleum Industries (API) recommended practices (or equivalent) prior to and during well drilling.	Sasol	Throughout the operation	International Well Control Forum (http://www.iwcf.org/) American Petroleum Industry (API) standards National Oil Spill Contingency Plan
			7.6	All responsible personnel will be qualified in accordance with International Well Control Forum requirements or equal.	Sasol	Throughout the operation	
8.	Treatment and Disposal of Drilling Fluids and Cuttings	Minimize biochemical impacts on marine environment.	8.1	Use Group III NADF of lowest toxicity sufficient to undertake drilling to optimal safety standards	Sasol	During drilling	International Finance Corporation (IFC) (2007) Offshore oil and gas development HSE Guidelines OGP, Report No. 342, 2003
			8.2	Treat drill cuttings to reduce oil content not exceeding 5% average weight and dry cuttings to facilitate optimal dispersion.	Sasol	During drilling	
			8.3	Monitor oil content of drill cuttings at least every 12 hours.	Sasol	During drilling	
			8.3	Discharge of cuttings to sea will be disposed of through a shunt pipe placed 3-5 m below the sea surface	Sasol	During drilling	
			8.4	Provide an estimate of the volume of rock cuttings dumped onto the sea floor before connection of marine riser.	Sasol	During drilling of initial hole sections	
			8.5	Provide an estimate of the volume of cuttings disposed overboard and location of discharge point and depth.	Sasol	At the end of the drilling operation	
9.	Well Testing	Avoid discharge of hydrocarbons to sea and minimize air emissions.	9.1	Use high efficiency flares and oil burners to maximize combustion of hydrocarbons and keep flare burners maintained to highest standards.	Sasol	During well testing	Flaring & venting in the oil & gas exploration & production industry (OGP, Report Nr. 2.79/288, 2000); NPI Petroleum
			9.2	Notify the National Petroleum Institute prior to flaring of gas	Sasol	Prior to well testing and gas flaring	

Activity		Objective	Actions to be Undertaken to Mitigate Environmental Impact		Responsibility	Frequency / Timing	Key Legislation /Standard
#	Description of Activity		#	Commitment / Actions Required / Key Controls			
			9.2	Adhere to appropriate well testing procedures to avoid discharges to sea.	Sasol	During well testing	Operations Regulations
10.	Waste handling and management	Responsible waste handling and management.	10.1	Ensure a waste management plan is in place to minimise, reduce, reuse and recycle wastes.	Sasol	Throughout operation	ÒGP Waste Management Guidelines (No.2.58/196, 1993)
			10.2 10.3	Ensure that monitoring procedures for waste management are undertaken in accordance with MARPOL requirements. Ensure that good operating procedures and controls are in place on board including systems for recording generated and disposed wastes.	Sasol	Throughout operation	International Convention for the Protection of Pollution from Ships MARPOL 73/78
			10.4	**Vessel Emissions** • No ozone depleting substances are to be used (apart from use in fire extinguishers or other response equipment and materials, as necessary). • Ensure all operation and maintenance of equipment follows manufacture's specifications to ensure highest possible level of efficiency to maintain minimum level of CO_2 and CO emissions.	Sasol	Throughout operation	Amendment to the Montreal Protocol on substances that deplete the Ozone Layer, 1990
			10.5	**Deck drainage, machinery space and ballast water** • Water will be analysed by processing units calibrated to operate in compliance with MARPOL standards. Valid calibration certificates must be available on the drilling rig.	Sasol	Throughout operation	MARPOL 73/78 IFC 2007) Offshore oil and gas development HSE Guidelines
			10.6	**Solid Waste** • Solid waste will be labelled and stored onboard prior to disposal at appropriate facilities.. • The selected disposal method will be addressed in the waste management plan prior to commencement of drilling. • All hazardous waste will be collected and retained onboard for disposal at suitable onshore reception facilities.	Sasol	Throughout the operation	ÒGP Waste Management Guidelines (No2.58/196, 1993) MARPOL 73/78

Activity		Objective	Actions to be Undertaken to Mitigate Environmental Impact		Responsibility	Frequency / Timing	Key Legislation /Standard
#	Description of Activity		#	Commitment / Actions Required / Key Controls			
			10.7	**Kitchen Waste** • Kitchen galley waste will be macerated to a size that can pass through a mesh size no larger than 25 mm. • No waste will be discharged to sea closer than 12 nautical miles from land.	Sasol	Throughout the operation	MARPOL 73/78 ÒGP Waste Management Guidelines (No2.58/196, 1993)
			10.8	**Sewage** • Sewage will be treated to MARPOL standards in an approved sewage treatment plant where it is comminuted and disinfected on the drilling and support vessel(s) and discharged when operating more than three nautical miles from land. • If operating beyond 12 nautical miles (21.6 km), sewage must be comminuted but does not require treatment before discharge. • Sewage effluent will be analysed by processing units calibrated to operate within the required limits. Calibration certificates must be available on the drilling rig.	Sasol	Throughout operation	MARPOL 73/78
11.	Equipment Loss	Minimize hazards left on the seabed or floating in the water column	11.1	Ensure that recovery procedures for lost equipment are in place.	Sasol	Throughout operation	-
			11.2	• Record events and location of lost material/equipment and their recovery, if recovery made; • Make all feasible attempts to recover lost equipment and if not feasible, record the type, details and location of the equipment; • Notify relevant authorities and stakeholders in the event of equipment loss, spill or accident.	Sasol	Throughout operation	-
			11.3	Review procedures in the event of an accident to reduce risk of recurrence.	Sasol	Throughout operation	-
12.	Bunkering at Sea	Minimize potential of HFO/diesel spills.	12.1	Diesel and other fuels will be stored in enclosed tank(s), designed to withstand normal and extreme events and conditions.	Sasol	Throughout operation	Oil spill response plan Oil Preparedness, Response and Co-
			12.2	Ensure that drip trays are in place to collect leakage from connection and discharge points.	Sasol	Throughout operation	

Activity		Objective	Actions to be Undertaken to Mitigate Environmental Impact		Responsibility	Frequency / Timing	Key Legislation /Standard
#	Description of Activity		#	Commitment / Actions Required / Key Controls			
			12.3	Offshore bunkering will not be allowed in the following circumstances: • Wind force and sea state conditions of 6 or above (Beaufort Wind Scale); • During any workboat or mobilisation boat operations; • During the transfer of in-sea equipment; and • During helicopter operations.	Sasol	Bunkering at sea	operation Convention (OPRC) MARPOL 73/78 Industry standards
			12.4	Floating hoses will be made of flexible double carcass sections and will be equipped with a breakaway coupling for protection against excessive tension or overpressures in the fuel system. The couplings will be the double closure petal type in order to minimise the volume of fuel spilled to the sea in case of activation. The closure time will be set to minimise the volume of oil spilled to the sea whilst being slow enough to prevent surge pressure building up. Hoses will also be fitted with marker lights and will have built-in buoyancy with a minimum reserve of 25% (to cope with a situation where the hose becomes filled with seawater and immersed). This will also prevent accidental damage to unseen hoses by supply/crew boats.	Sasol	Bunkering at sea	
13.	Logistical Helicopter Support	Minimise disturbance to marine fauna and tourists.	13.1	• Helicopter transfers must adhere to direct flight paths that avoid coastal and estuarine areas, offshore islands, known bird colonies and turtle nesting areas and fly at a minimum height of 500 m. • Avoid deviations from flight paths unless in case of emergency or other safety reasons • Do not deviate from flight paths to visit tourist areas of Bazaruto Archipelago National Park, or to circle or hover over whales, dolphins or dugongs. • Maintain and keep flight logs to check adherence to flight paths.	Sasol	Before, during and after operation	-
14.	Closure of well	Prevent hydrocarbon leakage from well and seafloor pollution and debris.	14.1	Safely abandon the well, if not suspended, by inserting concrete plugs in the well bore at various levels according to good oilfield practice and well abandonment policies.	Sasol	On completion of well testing	-
			14.2	Remove BOP stack, wellhead structure and lost equipment to leave the seafloor free of drilling equipment and waste (apart from cuttings).	Sasol	On completion of well testing	-

Activity		Objective	Actions to be Undertaken to Mitigate Environmental Impact		Responsibility	Frequency / Timing	Key Legislation /Standard
#	Description of Activity		#	Commitment / Actions Required / Key Controls			
			14.3	Well casings should be cut off approximately 3 m below the seafloor level for permanent well abandonments (ie at a depth that allows for natural changes in seabed levels. Where technical difficulties may preclude this, deviations can be considered with approval by MICOA and after consultation with the trawl fishing industry stakeholders.	Sasol	On completion of well testing	-
16.	Clearance of debris on sea bed	Remove environmental and fishing hazards on the sea floor.	16.1	Conduct post drilling side-scan sonar survey to check for drilling or well completion waste, or dropped equipment debris, and remove from seabed if any found. (See also point 21.1)	Sasol	Throughout the operation	-
17.	Well suspension (of future production wells)	Prevent any obstruction on the seafloor.	17.1	Should economically viable reserves be found at drilling sites, the well(s) will be plugged and temporarily abandoned in accordance with oil industry standards for possible use as a production or monitoring well(s) at a later stage. Notify other marine users of the position of the wellhead(s) and mark these on Notices to Mariners.	Sasol	On completion of well drilling	-
Decommissioning and Closure							
18.	Inform stakeholders of completion of Well Drilling and Testing	Keep key marine users and stakeholders informed of drilling completion.	18.1	Inform all relevant stakeholders of the completion of the operation and whether a well is abandoned or suspended.	Sasol	Within 14 working days after completion of drilling	-
19.	Final Waste Disposal	Ensure waste disposal minimizes pollution risks.	19.1	All waste retained onboard is to be disposed of by a licensed waste disposal contractor at an approved waste landfill site. The selected disposal methods and tracking system will be addressed in the Waste Management plan	Sasol	When vessel returns to port	-

Activity #	Description of Activity	Objective	Actions #	Commitment / Actions Required / Key Controls	Responsibility	Frequency / Timing	Key Legislation /Standard
Monitoring, Auditing and Reporting							
20.	Compliance auditing	Assurance that EMP is implemented.	20.1	Audits should, through examination of records retained by the drilling contractor and SPSL, verify that: o All records required by this Environmental Management Plan have been retained and are stored in an accessible and logical manner o All reports required by this Environmental Management Plan have been completed and submitted to the designated recipient o All monitoring has been completed and any deviances responded to accordingly, and o Management reviews have been conducted and were comprehensive and any action required has been implemented.	Sasol	During drilling and after completion of drilling	-
21.	Post-drilling monitoring	Assess actual impacts as a result of drilling operations.	21.1	Undertake seabed scans, including video and side-scan sonar, of the seabed state to assess the degree of potential impact on marine fauna and to confirm cuttings deposition model predictions based on obvious visual evidence. [This activity can be combined with post drilling survey to check that no equipment is left on the seabed (See point 16.1)]	Sasol	After drilling operation	-
22.	Monitoring Activities and Effects	Ensure compliance with effluent standards.	22.1	Monitor oil liquid effluent discharges to ensure compliance with MARPOL 73/78 standards: Water will be analysed by processing units calibrated to operate to international standards. Valid calibration certificates must be available on the drilling vessel. Where systems are not certified, analysis will be done for oil content on a daily basis.	Sasol	Throughout operations	International Convention for the Protection of Pollution from Ships MARPOL 73/78
23.	General Reporting	Record and report all incidents and discharges to sea.	23.1	Record volume of cement displaced to seafloor.	Sasol	Daily throughout operations	-
			23.2	Provide coordinates of wellhead and status to regulatory authorities, particularly INAHINA and INAMAR.	Sasol	On completion	
			23.3	Retain waste manifests (or inventory schedules) from the drilling vessel, and disposal logs from Waste Contractor for the legally applicable period.	Sasol	Throughout operation	

Activity		Objective	Actions to be Undertaken to Mitigate Environmental Impact		Responsibility	Frequency / Timing	Key Legislation /Standard
#	Description of Activity		#	Commitment / Actions Required / Key Controls			
			23.4	Record all incidents of oil spills and destination of wastes, and report all occurrences in accordance with the Oil Spill Contingency Plan.	Sasol	As per Oil Spill Contingency Plan	
			23.5	Record all incidents of interactions with shipping and other vessels	Sasol	Throughout operation	
			23.5	Obtain photographic evidence of removal of wellhead.	Sasol	After wellhead removed.	
24	Record Keeping	Demonstrate compliance with EMP	24	Records should be retained for periods specified by applicable laws and licence conditions. The following records shall be maintained to demonstrate compliance with the Environmental Management Plan. • Effluent discharge volumes • Effluent discharge quality results • Effluent quality exceedances • Incident reports • Air quality monitoring • ROV imagery of subsea conditions • Water manifests and waste characterisation • Waste production and disposal analyses • Training records • Prosecutions/ notices of non-compliance • Stakeholder inputs and the review thereof • Audit reports • Results of management reviews • Weekly, monthly and annual internal reports • Planned maintenance reports/ logs • All EIAs and application for environmental authorisations • All correspondence with permitting authorities such as MICOA and INP.	Sasol	Five years	

Section 6

Conclusion

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SECTION 6: CONTENTS

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11 CONCLUSION

Sasol Petroleum Senegala Limitada wishes to drill one to two wells in the offshore Sofala Concession of Sofala Bay in Mozambique at a distance of over 40-50 km from shore and in water depths of 50-100 m, but possibly in shallower depths. It is intended to use a jack up drill rig and to drill the wells up to a depth of 5,000 m. Jack up rigs are unable to operate in water shallower than 20 m.

The proposed drilling exploration activities are no different to the many offshore exploration activities undertaken throughout the world. However, the marine environment of Sofala Bay supports a large proportion of the Mozambican export fishery for penaeid shrimps, valued at 80 million dollars per year in exports in recent years (equivalent to three percent of GDP). The fishery also provides the basis for the livelihoods of several thousand artisanal fishers that live in settlements along the coastline, who are highly dependent on marine resources for food and income. The semi-industrial shallow water prawn fishery is focused on the area inshore of the M-10 Concession, industrial trawling for shrimp takes place to the north of Sofala Concession, and the Industrial bottom trawl fishery for deep water shrimp occurs in the deeper portions of M-10. No trawling takes place in the vicinity of the drill site locations.

To the south of the M-10 Concession, at a nearest distance of 50 km, the marine ecosystem of Bazaruto Archipelago National Park is highly prized for its unique array of biodiversity and sensitive ecosystems, comprising coral reefs and tropical fish, sea grass and dugongs, and a wide variety of other marine and coastal fauna. It is an internationally sought after tourist destination which has seen exponential growth in recent years, and which provides a key source of employment for local Mozambicans in and around Vilanculos.

Many of the impacts of drilling the proposed wells in the M-10 Concession are deemed to be of Negligible to Minor Significance provided that international best drilling practice is followed and international standards for drilling and other waste discharges (sewage, galley waste, deck drainage etc) are complied with, particularly in accordance with MARPOL (1) standards. A summary table of impact ratings is provided in *Table 11.1.*

The key potential impacts of drilling relate to the discharge of drill cuttings and associated residues of Non-Aqueous Drilling Fluids (2), and its associated

(1) International Convention for the Protection of Pollution from Ships (MARPOL).
(2) NADFs are hydrocarbon based fluids used to improve lubrication of the well in certain geological strata to avoid sticking of the drill. They mainly comprise a mix of non-aqueous fluid, barite, brine and small quantities of emulsifiers and gelling agents.

effects on the marine environment and the important fisheries, in particular. Modelling of these discharges predict drill cuttings to settle across a maximum area of 4.6 km^2 with a thickness less than 2 mm over most of the settlement area. Mounding would be limited to the immediate vicinity of the drill site. Benthic fauna have been found to be able to withstand smothering of up to 5 mm of sediment and would therefore only be affected where mounding occurs close to the drill site, and are not expected to be affected over most of the depositional area. The high energy tidal environment of Sofala Bay and the prevailing currents and tides on the Sofala Bank are predicted to disperse the cuttings discharge relatively quickly. No residual impact on marine fauna in the drill cuttings settlement zone is therefore expected within one to three years after drilling.

The location of potential drilling sites on the continental shelf of Sofala Bay covered by this EIA are 5-10 km away from the shallow water semi-industrial prawn fishing grounds and the deeper water prawn trawling areas (which intersects the deeper portions of the M-10 Concession). The closest previously identified well (Delta) is within the 10 km recommended buffer but is proposed to be shifted beyond the 10 km buffer zone. No trawling currently takes place in the near vicinity of the proposed drilling sites or the cuttings settlement zone. The turbidity plume from the drilling discharge may extend beyond the cuttings settlement area, with high turbidity levels extending up to 2 km of the drill site, decreasing over 5-10 km to ambient levels. Turbidity is expected to disperse rapidly down to general background turbidity levels and is predicted to have a minimal influence on the marine environment given the naturally high turbidity levels in Sofala Bay. The more expansive distribution of fines (silt and drilling fluids) could have biochemical effects if drilling fluids contain any toxic components. However, Sasol has undertaken to use a low toxicity Group III drilling fluid and to clean cuttings to 5% average weight. Rapid dispersal in the high energy environment of Sofala Bank to low contamination levels is unlikely to pose a risk to marine biota, and there are no known sensitive habitats (eg coral reefs or sea grass) in the Sofala Bank offshore environment.

As with any oil or gas drilling project in the world, the biggest risk lies with the consequences of a potential well blow out or vessel collision which could result in the release and spread of oil or condensate into Sofala Bay. The probability of such an oil spill, such as the recent BP blow out in the Gulf of Mexico, are exceedingly low (1:25,000 wells). Blow-outs are regarded as being of greater risk for deep water wells, which are more difficult to stop due to the greater water depths. A study indicated that of the estimated 15,000 wells drilled in the Gulf of Mexico from 1992 to 2006, there have been 39 blowouts, of which few released much oil and most were stopped within a week (Bourne, 2010).

Modelling of a worst case oil spill scenario in the M-10 Concession predicts the consequences of an oil spill would be felt most severely from the Save River Estuary southwards into the Bazaruto Archipelago with a high probability of oil reaching the shore within one to two days. The predominance of sensitive coastal ecosystems in the area (eg extensive mangroves and estuaries around Sofala Bay, and sea grass and coral reefs in BANP) could be seriously compromised ecologically in the event of a major oil spill, and would have significant implications for fisheries and tourism. Impact ratings are summarised in *Table 11.2*. The consequences of a spill would depend on the time of year, the type and quantity of oil spilled (heavy fuel oil, diesel or condensate), prevailing environmental conditions and the effectiveness of clean up interventions. In this regard Sasol will implement international best practice with regards to drilling operations which will further minimise the possibility of an oil spill, while at the same time having a detailed Oil Spill Contingency Plan and allocated resources to deal with an oil spill should it occur.

In the absence of any major impacts predicted to arise from normal drilling operations, the extremely low probability of an oil spill but high consequences are unlikely to preclude authorisation of the project especially given the potential economic benefits that might accrue from the offshore oil and gas industry. However, given the potential consequences of a blow out, it is imperative that all possible precautions and safeguards are taken to avoid such an event.

A Strategic Environmental Assessment of the Mozambique coastal region has been commissioned by MICOA and is due to commence shortly. The SEA will attempt to address conflicting inter-sectoral issues as a basis for decision-making and to guide investment decisions between various industries where development of one industry may conflict with the requirements of another.

Table 11.1 Summary of Well Drilling and Well Testing Impacts

Cause & Nature of Impact	Potential Impact	Assessment of Impacts								
		Magnitude Criteria								Confidence
		Extent	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance (embedded mitigation)**	**Mitigation (in brief)**	**Significance (additional mitigation)**	
Rig positioning on sea bed	Physical damage to benthic fauna and turbidity effects on water column biota	Site (localised effect at drill rig location)	Short-term (120-day drilling period)	Low (benthic fauna widely distributed and will recolonise)	Low	Definite	**MINOR**	Scan seabed to verify absence of sensitive habitats and remove left or dropped objects	**NEGLIGIBLE**	High
Lighting and flaring from the rig	Lights and flaring may attract sea birds and other marine fauna that may be injured or killed.	Site (drill rig location)	Short-term (120-day drilling period)	Low (low species numbers affected)	Low	Likely	**MINOR**	Shield or reduce lights to limit range of illumination. Collect disoriented birds and release.	**NEGLIGIBLE**	High
Helicopter and service vessels: noise and vibration	Noise and presence close to sensitive species may disturb marine fauna eg whales	Regional (Beira – Sofala Bay area)	Short-term (120-day drilling period)	Low (transient impact)	Low	Likely	**MINOR**	Helicopters to adhere to flight paths and maintain 500 m height in transit. Service vessels to maintain 350 m distance from cetaceans.	**NEGLIGIBLE**	High
Noise from drilling	Noise may disturb marine fauna eg whales, turtles etc	Local (within 10 km range)	Short-term (120-day drilling period)	Low (noise levels similar to ships in transit)	Low	Likely	**MINOR**	Check for marine mammals before undertaking very noisy activities and landing helicopters. Maintain equipment.	**NEGLIGIBLE**	High

Cause & Nature of Impact	Potential Impact	Assessment of Impacts									
		Magnitude Criteria									Confidence
		Extent	Duration	Intensity	Magnitude	Likelihood	Significance (embedded mitigation)	Mitigation (in brief)	Significance (additional mitigation)	
Release to sea of drill cuttings with residues of drill fluids	Settlement of drill cuttings may smother benthic fauna	Local (close vicinity to drill site)	Short-term (120-day drilling period)	Low (deposition predicted to be <2mm thick over most of settlement area)	Low	Definite	**MINOR***	Release cuttings from deeper sections 3-5 m below sea level to aid dispersion	**NEGLIGIBLE**	High
	Increased turbidity may adversely affect water column fauna eg plankton	Local (maximum of 5-10 km around rig)	Short-term (120-day drilling period)	Low (ambient turbidity high at times and majority of cuttings will settle quickly)	Low	Likely	**MINOR***	Release cuttings from deeper sections 3-5 m below sea level to aid dispersion	**NEGLIGIBLE**	High
	Contamination effects on marine life	Local (maximum of 5-10 km around rig)	Medium-term (1-3 years to recover)	Low (depositional area maximum 2 mm thick and rapid bio-degradation expected)	Low	Likely	**MINOR***	Use low toxicity biodegradeable drilling fluids (eg. Group III Non-Aqueous Drilling Fluid)	**NEGLIGIBLE**	High
Gaseous emissions from flaring & generators	Increased air pollution on atmosphere	Local (within 500 m of rig)	Short-term (120-day drilling period)	Low (minor quantities of gases)	Low	Likely	**MINOR**	Regular maintenance of equipment, generators and flare burners to burn at high efficiency	**NEGLIGIBLE**	High

Cause & Nature of Impact	Potential Impact	Assessment of Impacts									
		Magnitude Criteria									Confidence
		Extent	Duration	Intensity	Magnitude	Likelihood	Significance (embedded mitigation)	Mitigation (in brief)	Significance (additional mitigation)	
Release of contaminated deck drainage & machinery and ballast water	Oily water can contaminate marine environment	Local (vicinity of drill vessel; 500 m radius)	Short-term (120-day drilling period)	Low (minor amounts of oily polluted water will disperse and dilute rapidly)	Low	Likely	**MINOR***	Comply with MARPOL standards: Machinery space 15mg/l Other effluents <40 mg/l (monthly average) Other effluents <100mg/l (instantaneous limit)	**NEGLIGIBLE**	High
Sewage and galley waste discharges to sea	Increased disposal of organic matter to sea increased bacterial loading and biological oxygen demand	Local (vicinity of drill vessel)	Short-term (120-day drilling period)	Low (organic waste will be quickly degraded and dispersed)	Low	Likely	**MINOR***	Comply with MARPOL standards: Macerate organic food to <25 mm size and discharge beyond 3 nautical miles of shore; Macerate sewage and discharge beyond 12 nautical miles, or macerate and treat sewage and discharge beyond 3 nautical miles.	**NEGLIGIBLE**	High
Production of garbage and solid waste	Disposal to sea of certain wastes will pollute marine environment	Local (vicinity of drill vessel or end location)	Short-term (120-day drilling period)	Low (isolated / accidental waste items only)	Low	Likely	**MINOR**	Comply with MARPOL standards and Waste Management Plan (to be produced prior to drilling): No plastic to be disposed of to sea. Segregate and recycle waste and dispose onshore to appropriate facilities.	**NEGLIGIBLE**	High

Cause & Nature of Impact	Potential Impact	Assessment of Impacts									
		Magnitude Criteria									Confidence
		Extent	Duration	Intensity	Magnitude	Likelihood	Significance (embedded mitigation)	Mitigation (in brief)	Significance (additional mitigation)	
Rig has 500m exclusion zone and drill cuttings may affect fish & prawn populations	Interference with artisanal and industrial fishing through loss of access or disturbance of fish/prawn stocks	Local (maximum 5-10 km of rig due to turbidity plume)	Short-term (120-day drilling period)	Low (drill cuttings will disperse rapidly and	Low	Likely	**MINOR**	Use Group III NADP to minimise risk of biochemical impacts. Discharge drill cutting 3- 5 m below sea surface.	**NEGLIGIBLE**	High
Presence of the drilling vessel creates a visual impact	Visual and perceived loss of sense of place on tourism	Regional (visibility from other users in Sofala Bay)	Short-term (120-day drilling period)	Low (drilling vessel at least. 23 km from shore and >80 km from main tourist area of Bazaruto)	Low	Unlikely	**NEGLIGIBLE**	Keep stakeholders informed of drilling activities.	**NEGLIGIBLE**	High
Presence of drilling vessel and operation of support vessels creates a navigational impact	500 m exclusion zone and regular transit of support vessels may interfere with passage of vessels and pose navigational risk	Regional (Sofala Bay marine users)	Short-term (120-day drilling period)	Low (marine traffic entering and leaving Beira and likely to be affected is low)	Low	Likely	**MINOR**	Inform fishing and shipping representatives of drilling rig location and support vessel activities. Notify marine users with standard navigational measures. Maintain communication aids and ensure look out on bridge at all times.	**NEGLIGIBLE**	High

Cause & Nature of Impact	Potential Impact	Assessment of Impacts								
		Magnitude Criteria								Confidence
		Extent	Duration	Intensity	Magnitude	Likelihood	Significance (embedded mitigation)	Mitigation (in brief)	Significance (additional mitigation)	
Drilling will disturb sea bed and possible shipwrecks	Unknown shipwrecks could be affected by drilling	Site (drilling site)	Permanent (if ship-wreck affected)	Low (side scan surveys prior to drilling may detect presence)	Low	Unlikely	**NEGLIGIBLE**	Undertake sea bed survey with side scan sonar prior to drilling. Alert INAMAR if shipwreck found.	**NEGLIGIBLE**	Moderate
Wellheads may be suspended on sea floor for future use	Suspended well heads with 500 m exclusion zone will preclude trawling	Site (500 m exclusion zone	Long-term (depends on time until abandoned)	Low (no trawling takes place in the area of the drill sites)	Low	Unlikely	**MINOR**	Mark location of suspended wellheads on Notice to Mariners and inform fishing stakeholders.	**MINOR**	High
Increased presence of foreign workers in Beira	Increased health risks associated with HIV/AIDS and STDs and impacts on social cohesion	Local (Beira)	Short-term	Low	Low	Likely	**MINOR**	Education and awareness risk of HIV/AIDS and STDs through sexually inappropriate behaviour. Provision of condoms to staff.	**NEGLIGIBLE**	High
Increased expenditure in Beira	Purchase of goods and services in Beira by project staff will have economic benefits	Local (Beira)	Short-term	Low	Low	Likely	**MINOR**	SPSL should invite and consider tenders from local suppliers and consider all tenders in a fair and transparent manner	**MINOR**	High

* Assumes mitigation measures are embedded and complied with.

Table 11.2 Summary of Impacts in the Event of Major Oil Spill Event (eg. well blow out or vessel collision)

Cause & Nature of Impact	Potential Negative Impact	Assessment of Impacts								
		Magnitude Criteria								Confidence
		Extent	Duration	Intensity	Magnitude	Likelihood	Significance (embedded mitigation)	Mitigation (in brief)	Significance (additional mitigation)	
Worst Case Oil Spill Event	Damage / loss of sensitive marine and coastal habitats and species	Regional to International (Bazaruto is a National Park)	Long-term	High (depends on type and amount of oil spilled, and prevailing conditions)	High	Likely (impact is likely to occur in the improbable event of a major spill)	**MAJOR**	Compliance with National Oil Spill Contingency Plan (NOSCP) and SPSL developed Oil Spill Response Plan.	**MODERATE**	Moderate - High
	Oil pollution of the marine environment would impact tourism at Bazaruto & Sofala Bay	Regional to International (Bazaruto is a prime international tourist destination)	Medium (depends on success of clean up actions	High (depends on type and amount of oil spilled, timing of spill and prevailing conditions)	High	Likely (impact is likely to occur in the improbable event of a major spill)	**MAJOR**		**MODERATE**	Moderate
	Reduced fish / prawn catches by artisanal fishers; reduce livelihoods, and oil fishing equipment	Regional - International (Sofala Bank fishery is major export fishery)	Medium	High (especially if oil spill occurred in peak prawn spawning or catching season)	High	Likely (impact is likely to occur in the improbable event of a major spill)	**MAJOR**		**MODERATE**	Moderate
	Reduced fish / prawn catches by industrial fishers, and oiling of equipment, causing loss of livelihood,	Regional - International (Sofala Bank fishery is major export fishery)	Medium	High (especially if oil spill occurred in peak prawn spawning or catching season)	High	Likely (impact is likely to occur in the improbable event of a major spill)	**MAJOR**		**MODERATE**	Moderate

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Annex A

Terms of Reference for the EIA and Public Participation Process

TERMS OF REFERENCE FOR THE ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Taking into consideration the potential impacts identified during the Scoping Phase (outlined in Chapter 2), a number of specialist studies are required in order to address the main issues of concern. The following studies are recommended:

- Marine Ecology and Mammals Study;
- Dispersion Modelling Specialist Study (Hydrocarbon spill and drill cutting dispersion);
- Fisheries Study;
- Tourism Study;
- Socio-economics Study;
- Effects on marine traffic (shipping, fishing vessels); and
- Legal Assessment.

The EIS will mainly comprise an extensive review and updating of the EIS Report for ARCO's seismic survey in 1998 and the BANG survey in 2008, as well as exploratory drilling in the Sofala Concession by ARCO, in 2000 and other studies deemed necessary.

1. Marine ecology and mammals

The aim of the marine ecology and mammals study is to obtain baseline information on marine ecology and the occurrence and distribution of marine mammals in the study area and to assess the impact of the project activities on the marine environment. To do this the Marine ecology and mammals study should achieve the following:

- Provide a detailed description of the affected environment by reviewing existing biophysical literature pertaining to the coastal and marine environment likely to be impacted by the drilling programme. The description should include:
  - Marine biota characterization including plankton, benthic communities, invertebrates (including shrimp), fish, turtles, birds and mammals (whales, dolphins, dugongs). Rare and endangered species, particularly marine mammals, to be identified.
  - Coastal and marine habitats (e.g. estuaries, coastal lagoons, tidal sand and muds flats, beaches, mangroves, angiosperm beds, coral reefs, coral "bommies", rocky shores, turtle nesting beaches, etc) that may be potentially affected by the proposed activities.
- Identify sensitive habitats and species that may be potentially affected by the proposed exploration activities.
- Review international literature and other studies that have researched the impact of off-shore exploration activities on the marine environment, especially case studies where exploration activities have occurred in sensitive environments and in the vicinity of protected areas and reference the mitigation measures which were employed.

2. Dispersion Modelling (Hydrocarbon spills and Drill cutting dispersion)

This specialist study will comprise of two sections. The first component of the study is aimed at understanding how drill cuttings and drill muds will be dispersed during drilling operations. The second component of the study will include modelling of the transport and fate of hydrocarbons in the case of accidental release of hydrocarbons during drilling. The outputs of this study will be used by the Marine Ecologist to assess the potential impact of the dispersion of drill cuttings and muds on the marine environment and the impact of potential hydrocarbon spills.

The requisite model simulations will be undertaken and model outputs provided in a format appropriate for the assessment of potential environmental impacts associated with discharges/accidental releases.

The approach adopted in this specialist study will combine the strengths of calibrated models to explore transport and fate scenarios and ask the "What If?" spill scenario questions, with existing observationally based data on the ecological and socio-economic characteristics of the coastal environment provided by the marine ecology and socio-economic specialist studies.

The approach to the study will be to set-up, calibrate and verify a suitable three dimensional hydrodynamic model to provide the necessary hydrodynamic data base for the subsequent drill cuttings and muds dispersal and hydrocarbon release simulation.

Hydrodynamic Modelling Study

A suitably calibrated three-dimensional hydrodynamic model will be set-up that covers the region of interest, i.e. Concessions M-10 and Sofala. The accurate simulation of the hydrodynamics of the region is important in that it is likely to compromise a complex hydrodynamic domain.

<u>Drilling Discharge Simulations:</u>

This study will only investigate the marine disposal of drill cuttings and drilling muds (i.e. the first two of the bullets above).

A numeric computer modelling system will simulate the mud/cuttings discharges, reproducing the dispersion and sea bottom sedimentation of bulk discharges during the drilling program. Each modelling scenario will assume a particular discharge from a site location (e.g. single well or combination) and can reproduce different drilling sections and their corresponding disposals on the seabed or on the water surface accordingly to a single drilling program.
Mud/Cuttings dispersion modeling outputs will provide a description of the water column turbidity contours and sea bottom deposition at the end of the assumed drilling program, expressed as accumulated bottom thickness.

The modelling will provide both spatial and temporal information on parameters such as:

- Water column turbidity;
- Produced water and sediment distribution (and redistribution); and

- Sediment thickness on the seabed related to the release of the drill cuttings and muds.

Oil/Diesel Spill Simulations

The modelling study will include several oil/diesel spill simulations. Four scenarios will be modelled for different locations and different products/volumes. A numerical computer modelling system will be used in both stochastic and deterministic mode to compute sea surface and shoreline contact of surface oil for releases from the specified spill sites, as well as weathering calculations. Oil/diesel spill model results will provide probability of surface oiling and spill 'travel time' contours. For each (stochastic) spill scenario, a representative or 'worst case' will be determined, typically the shortest time to shore.

The information obtained from these assessments will be used to inform the impact assessment, EMP and the mitigation measures to be proposed.

3. Fisheries study

The purpose of this study is to understand the extent of the fishing resources in the project area and to identify the commercial, subsistence and recreational fishing activities. The study will be based on existing data from the Fishery Research Institute, Small-Scale Fishery Development Institute and fishery research.

The out-puts of this study will be used by the socio-economics team to assess the potential socio-economic impacts of this project and to determine mitigation measures as well as help define an approach to compensation.

The specialist undertaking this study will work closely with the marine ecologist and socio-economic team to ensure that there are no gaps in the information requirements of these studies.

The fisheries study will include:

- a description of the existing subsistence, semi-industrial, industrial and recreational fisheries in the region including:
- fishing seasons,
- fishing techniques, (type of vessel, nets, fishing periods)
- number and types of fishing vessels (commercial and artisan),
- number of registered fishermen,
- location of fishing grounds,
- species that are fished, including shrimp;
- approximate economic value of fishing activities (commercial and subsistence);
- a summary of the existing information on oceanic resources in the area of interest and their importance to the fisheries industry and possible impacts of the activities on these resources.

The above will be achieved by reviewing existing information (previous EIAs, publications, etc).

4. Tourism Study

As most of the baseline data is already available from various studies carried out in the same geographical area (including the EIA for the seismic acquisition activities in Concession M-10), the Consultant is required to review and update (where necessary) the information pertaining the tourism situation in the project area.

Updated information about construction/licenses for tourism developments will be obtained from tourist operators and the provincial government in Sofala and Inhambane (Provincial Directorate of Tourism).

Desktop research will include the following:

- Desktop analyses and a literature review of existing literature on the area, other recent studies conducted in the area, maps, and aerial photographs;
- Inclusion of information gathered through other baseline studies into the EIA; and
- Ongoing contact with other project personnel to share and elaborate on information.

5. Socio-economic study

The aim of the socio-economic study is to assess the potential socio-economic impact resulting from the project activities. In order to do this, the specialist study should include the following:

- A summary description of the socio-economic conditions of the two provinces and the four districts that lie in the project area. This must include a demographic profile, organizational and traditional social structures, economic activities, employment, development plans and poverty profiles (the information will be obtained from secondary sources);
- A description of the socio-economic conditions in the project area, with particular reference to the coastal areas and the BANP, giving special attention to the role of fishing activities and tourism in the local and regional economies, and the role of women and gender issues in local livelihoods analyses. The following details should be covered:
    - Population settlement and demographic profile and patterns by location,
    - Social organization, state and community power structures,
    - Main livelihood sources, fishing, agriculture and food security,
    - Main sources of family income with special reference to subsistence fishing and employment in the tourism sector,
    - Levels of urban and rural poverty.

- An assessment of and suggested possible synergies which the project might be able to develop with institutions representing interested and affected sectors such as Fishermen Associations and Tourism Operators, institutions connected to conservation and local NGOs, with a view to creating a permanent communication link for uninterrupted dialogue; and

- An assessment and suggested possible synergies that the project may be able to develop with other local development initiatives.

6. Effects on marine traffic (shipping, fishing vessels)

The aim of this study is to understand the level of shipping operations along the coast that may be affected by the proposed exploration activities and potential impacts on Beira Port. To achieve this, the following should be undertaken:

- Provide a description of the shipping activities in and around Concessions M-10 and Sofala;
- Provide a description of the shipping routes; and
- Assess the potential impact of exploration activities on shipping and provide recommendations to minimize these impacts.

7. Legal Review

An independent legal review will also be undertaken to ensure that the project complies with all relevant legal requirements.

TERMS OF REFERENCE FOR THE

PUBLIC PARTICIPATION PROCESS (PPP)

The EIA Process for the activities proposed by Sasol for the offshore drilling exploration activities in Concession M-10 has involved the public from the initial stage. For this purpose, a Public Consultation Strategy was prepared and agreed in the initial stages of the project and a Background Information Document (BID) was distributed to the Stakeholders.

The Public Participation Process will be undertaken in accordance with the EIA Regulations (Decree nr. 45/2004) and the Public Participation General Directive (Ministerial Diploma 130/2006, for Category A projects). The Public Participation Process will aim to be both transparent and integrative, allowing the Interested and Affected Parties (I&APs) to understand the project and to enable them to identify issues of concern.

The Public Consultation (PC) will be conducted in two phases (i) during scoping to present the draft Environmental Pre-feasibility and Scope Definition Study (EPDA) Report and Terms of Reference (ToR) for the Environmental Impact Study (EIS), and during (ii) impact assessment to present the draft EIA report.

Public Consultation during the Scoping Phase

As described in the Section 2.1 of the Scoping Report, the following activities were undertaken as part of the Public Participation Process for the Scoping Phase:

- Consultation with relevant government departments;
- Distribution of the Background Information Document (BID) to I&APs and invitations to public meetings;
- Advertising of public meetings (newspapers, radio, website);

- Public meetings;
- Production of the Draft Scoping Report;
- Distribution of the Draft Scoping Report to public for comment;
- Gathering Public comment on the Draft Scoping Report; and
- Inclusion of the public comments into a Final Scoping Report and submission to MICOA for approval.

The Consultant held public meetings in Maputo, Beira and Govuro, preceded by public announcements through radio and newspaper including direct invitations to individual I&APs. These meetings presented the proposed activity, the proposed EIA process and gathered information from the I&APs on their expectations and concerns regarding the proposed activity.

In addition, communication channels with I&APs (telephones, fax, email and website) have been created to allow I&APs to easily communicate their concerns and comments.

The Draft Scoping Report was submitted to public consultation from 23 - 27 August 2010, to allow the I&APs to comment on the report and Terms of Reference (ToR) for the EIA. These comments were reflected in the Final Scoping Report for submission to MICOA and will be incorporated in the EIA.

Public Consultation during the EIA Phase

The Preliminary EIA Report will also be submitted to the public for comment, and the document will be made available in Maputo, Beira and Govuro. Public meetings will also be conducted at this stage.

All the comments received during the public participation process will be appropriately registered and will be reflected in the Scoping and EIA reports.

Annex B

Letter of Approval from MICOA

REPUBLICA DE MOÇAMBIQUE

MINISTÉRIO PARA A COORDENAÇÃO DA ACÇÃO AMBIENTAL

DIRECÇÃO NACIONAL DE AVALIAÇÃO DO IMPACTO AMBIENTAL

DNAIA

À:
IMPACTO, Lda
Exmo Senhor Dr António E. L. Couto
Director Geral

Maputo

Nossa Refª Nº 756 **GDN/DNAIA/MICOA/10** **Data: 15-07-2010**

Assunto: Estudo de Impacto Ambiental do Projecto de Perfuração de Blocos de Pesquisa de Hidrocarbonetos nos Blocos de Sofala e M-10 ao largo das Provincias de Sofala e Inhambane

Exmo Senhor,

A DNAIA recebeu de V.Excia o documento em epígrafe para a instrução do processo. Da sua análise, e de acordo com o anexo I, 4.6, alínea b, do Decreto 45/2004, de 29 de Setembro, a sua implementação é condicionada à elaboração do Estudo de Impacto Ambiental(EIA).

A anteceder ao EIA, o proponente deverá submeter para cada projecto, treze (13) cópias do Estudo de Pré-viabilidade Ambiental e Definição do Âmbito (EPDA) e Termos de Referência (TdR), em suporte de papel, e uma (1) em suporte electrónico à DNAIA, e cinco (5) cópias em suporte de papel deverão ser submetidas à Direcção Provincial para a Coordenação da Acção Ambiental de Sofala e outras cinco (5) à Direcção Provincial para a Coordenação da Acção Ambiental de Inhambane.

Com os melhores cumprimentos.

Atenciosamente,
Rosa Cesaltina Benedito
Directora Nacional

C.C: DPCA-Sofala
DPCA-Inhambane

Av. Acordos de Lusaka, 2115 • C. P. 2020 • Maputo • Telefone: 2146 6245 Fax: 2146 6245

Annex C

Legal Review

B1 LEGAL REQUIREMENTS

B1.1 EXPLORATION AND PRODUCTION CONCESSION CONTRACT (EPC)

SPM-10 signed an Exploration and Production Concession (EPC) contract with the Government of the Republic of Mozambique for Offshore Blocks M10 and Sofala.

The EPC was approved by Decree in January 2007. This contract gives SPM-10 exclusive rights to explore for and produce commercial quantities of hydrocarbons in the blocks. As part of the agreement SPM-10 has committed to drill 1 well in each Block before 31 January 2012 when the exploration period expires. Following exploration activities and in the event of a hydrocarbon discovery, the concessionaire/operator must declare to the Minister of Mineral Resources whether or not this discovery is "Potentially Commercial". Such declaration is usually made based on short-term appraisal studies following the discovery.

In the event of commercial discoveries being made, a comprehensive Development Plan must be produced that will be submitted to the Council of Ministers for approval before any field development and construction can begin. Such a Development Plan will have to include the need to conduct a separate EIA focusing on the impacts of continuous offshore hydrocarbon production.

The EPC also establishes and refines the off-shore block's boundaries as illustrated in ***Figure 1***. In relation to the previous concession boundaries, SPM-10 relinquished 25% of the license on February 1st 2010 when entered into the 2nd exploration period1 (**Figure 3** shows the Exclusion Zones - the areas that were relinquished by SPM-10).

In terms of its Exploration and Production Concession Contract with the Government of Mozambique, SPM-10 has the obligation to adhere to the Regulation for Petroleum Operations (Decree nr. 24/2004) and all other relevant environmental legislation of the Republic of Mozambique. In pursuance of this obligation, SPM-10 has committed to undertaking a full EIA.

Besides the Mozambican legislation, SPM-10 is also obliged to ensure that its operations comply with International Conventions to which the Republic of Mozambique is a signatory. Several conventions and agreements have been identified which relate to marine and coastal environments, as well as those regarding hazardous substances.

Relevant international conventions and national legislation for the proposed Offshore Exploration Drilling Operations are presented below.

1At the end of each exploration period the concessionaires have to relinquish part of the license.

In addition, Sasol's Safety, Health and Environmental Policy will also guide management approaches throughout the proposed exploration activities as well as international guidelines for the Petroleum Industry Sector.

B1.2 RELEVANT INTERNATIONAL CONVENTIONS

As per Article 18 of the Constitution of the Republic of Mozambique (2004 CRM), published in the Official Gazette on 22 December 2004, the duly approved and ratified Conventions and Treaties become effective on the date of their publication in the Official Gazette. Until such time they are not binding upon the Mozambican State. Relevant international maritime conventions include the following:

B1.2.2 OILPOL, 1954

The discharge of oil or oily mixtures into the sea from vessels is regulated by the terms of the International Convention for the Prevention of Pollution of the Sea By Oil (OILPOL). While the Convention does not deal with the releases from offshore installations per se, it regulates vessels operating in offshore oil fields by prohibiting the deliberate discharge of oil or oily mixtures from nearly all seagoing vessels in specific areas called 'prohibition zones'. Prohibited zones generally extend at least 50 miles (80 km) from all land areas.

B1.2.3 MARPOL, 1973

The Republic of Mozambique acceded to the International Convention for the Protection of Pollution from Ships (MARPOL) and to its 1978 Protocol by means of Resolution No. 5/2003, of 25 February2. Throughout most of the world, MARPOL has superseded OILPOL, and MARPOL standards are adhered to by most offshore operators. MARPOL places restraints on the contamination of the sea, land and air by ships. It has two protocols dealing respectively with reports on incidents involving harmful substances and arbitration; and five annexes which contain regulations for the prevention of various forms of pollution:

- Annex I - Prevention of Pollution by oil;
- Annex II - Control of pollution by noxious substances;
- Annex III -Harmful substances carried in packaged form;
- Annex IV -Prevention of pollution by sewage; and
- Annex V - Prevention of pollution by garbage from ships.
- Annex VI -Prevention of Air Pollution from Ships

Parties must accept Annexes I and II, but the other Annexes are voluntary. Mozambique has ratified Annexes III, IV, and V, but still has to ratify Annex VI (Prevention of Air Pollution from Ships).

2The Resolution No. 5/2003 of 18 February is published in Boletim da República (Official Gazette) No. 7, 1st Series, 3rd Supplement of 25 February 2003

Annex I: Prevention of pollution by oil.

Entry into force: 2nd October 1983. Revised Annex I entered into force 1st January 2007.

Annex 1 of MARPOL mainly pertains to oil pollution from oil tankers. However, Chapter II, Regulation 9 states that discharges into the sea of oil or oily mixture from ships shall be prohibited except when the following conditions satisfy:

"…from a ship of 400 tons gross tonnage and above other than an oil tanker and from machinery space bilges excluding cargo pump-room bilges of an oil tanker unless mixed with oil cargo.

- the ship is not within a special area;
- the ship is more than 12 nautical miles from the nearest land;
- the ship is proceeding en route;
- the oil content of the effluent is less than 100 parts per million; and
- the ship has in operation an oil discharge monitoring and control system, oil-water separating equipment, oil filtering equipment or other installation."

Annex II: Control of pollution by noxious liquid substances.

Entry into force: 6th April 1987 (Revised Annex II entered into force 1st January 2007).

Annex II details the discharge criteria and measures for the control of pollution by noxious liquid substances carried in bulk.

Some 250 substances were evaluated and included in the list appended to the Convention. The discharge of their residues is allowed only to reception facilities until certain concentrations and conditions (which vary with the category of substances) are complied with.

In any case, no discharge of residues containing noxious substances is permitted within 12 miles of the nearest land.

Annex III: Prevention of pollution by harmful substances in packaged form.

Entry into force: 1st July 1992.

Annex III is the first of MARPOL optional annexes and contains general requirements for the issuing of detailed standards on packing, marking, labeling, documentation, stowage, quantity limitations, exceptions and notifications for preventing pollution by harmful substances.

Annex IV: Prevention of Pollution by Residual Waters from Ships

Entry into force: 27th September 2003

Annex IV defines, in detail, how to handle or preserve residues on the ship and the circumstances in which discharge into the ocean can be allowed. It requires the Convention Parties to provide for adequate containers to hold the residues and includes a model of an International Certificate for the Prevention of Pollution from Sewage that can be issued by the national navigation authority for ships under its jurisdiction.

The Annex is applied to ships that make international trips. It is applied to all new ships with 400 tons and higher and new vessels with less than 400 tons that are certified to take more than 15 people. It will be applied to existing vessels of 400 tons and higher and new vessels with less than 400 tons but that are certified to take more than 15 people, five years after its entry into force.

The discharge of residues into the ocean is forbidden, except when the ship has an operation approved device for treatment of residue or when it is discharging disinfected residues and in small amounts, using an approved system at more than three nautical miles from the nearest coast; or discharging non-disinfected and un-fragmented residues, at more than 12 nautical miles from the nearest coast.

Annex V: Prevention of pollution by garbage from ships.

Entry into force: 31st December 1988.

This deals with different types of garbage and specifies the distances from land and the manner in which they may be disposed of. The requirements are much stricter in a number of "special areas" but perhaps the most important feature of the Annex is the complete ban imposed on the dumping into the sea of all forms of plastic.

Under Annex V of the Convention, garbage includes all kinds of food, domestic and operational waste, excluding fresh fish, generated during the normal operation of the vessel and liable to be disposed of continuously or periodically.

Annex VI: Prevention of Air Pollution from Ships.

Adoption: September 1997.
Entry into force: 19th May 2005.

As Mozambique does not have specific standards for this type of project or for pollution from ships, it is recommended that this Annex is adopted.

The regulations in this annex set limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibit deliberate emissions of ozone depleting substances.

Sulphur Oxides:

Annex VI IMO of MARPOL 73/78, that entered into force on 19th May 2005, limits the sulphur content of heavy oils to a maximum of 4.5 % m/m globally and a maximum of 1.5 % m/m in SOx Emission Control Areas (SECAs)3. In alternative, if the ship is equipped with an approved cleaning system for subsequent treatment of exhaustion gases or any other technical method that is verifiable and that reduces SOx emissions to a maximum of 6.0 g/kWh measured as $S0_2$4.

NOx Emissions:

The limits of NOx emissions are established for diesel engines that vary from 9.8 to 17 g/kWh depending on the engine's maximum operating speed, as shown in **Table 1.**

Table 1 **Annex VI MARPOL NOx Emission Limits**

Engine Speed (n, rpm5)	**NOx, g/kWh**
n < 130 rpm	17.0
130 rpm ≤ n < 2000 rpm	$45 \cdot n^{-0.2}$
n ≥ 2000 rpm	9.8

More technical details on NOx emissions, such as methods to control emissions, are included in the mandatory "Technical NOx Code", that was adapted under the coverage of "Resolution 2".

Other air pollutants:

Annex VI forbids the deliberate emission of substances that can harm the ozone layer, including halon and chlorofluorocarbons (CFCs). New facilities that contain substances that harm the ozone layer are forbidden in all ships. But the new facilities that contain hydro-chlorofluorocarbons (HCFCs) are allowed up to 1st January 2020.

The Annex also forbids the on-board incineration of certain products, such as contaminated packaging materials and polychlorinated Biphenyl (PCBs).

MARPOL is noteworthy among international marine conventions in that it is one of the few that prescribes specific limits on discharges rather than focusing on strategic policy objectives.

3m/m = per mass (1% m/m means that the mass of the substance is 1% of the total mass of the solution or mix)
4g/kWh = grams per kilowatt-hour
5rpm = rotations per minute

B1.2.4 OPRC, 1990

The Oil Pollution Preparedness, Response and Co-operation Convention (OPRC) came into force in May 1995 and relates to oil pollution of the marine environment throughout the world from offshore units. In particular, countries or national governments must establish national programs for responding to oil pollution incidents, while operators of offshore units are required to have oil pollution emergency plans in place, which are co-coordinated with the national oil response program. Further sections of the Convention deal with provision of oil pollution combating equipment, reporting, training, salvage and international cooperation. Very important are the provisions provided in Articles 6º, 3º and 4º of the Convention.
Article 6 determines that each Party shall have «a national system for responding promptly and effectively to oil pollution incidents». The same article also lays down the main aspects of the contents of such a national system.
Article 3 of the Convention determines that each State Party shall require that «operators of offshore units under its jurisdiction have oil pollution emergency plans, which are co-ordinated with the national system established in accordance with article 6 and approved in accordance with procedures established by the competent national authority».
Article 4 lays down the procedures to be adopted with respect to reporting oil pollution and in the case of an occurrence that involves or is susceptible to involve discharge of oil in the offshore unit.
The following sections of the Convention are related to the provisions of spill containment equipment, reporting, rescue and international cooperation.

The Republic of Mozambique acceded to OPRC by way of Resolution No. 6/2003, of 18 February6.

B1.2.5 IOPC FUND, 1992

The 1992 International Oil Pollution Compensation Fund (IOPC 1992 Fund) consists in an international regime of liability and compensation for oil pollution damage caused by oil spills from tankers. Under the regime the owner of a tanker is liable to pay compensation up to a certain limit for oil pollution damage following an escape of persistent oil from his ship. If that amount does not cover all the admissible claims, further compensation is available from the 1992 Fund if the damage occurs in a State which is a Member of that Fund. As per Resolution No. 53/2001, of 6 November7, the Republic of Mozambique withdrew from the IOPC 71 Fund and acceded to the IOPC 1992 Fund.

6The Resolution No. 6/2003 of 18 February is published in Boletim da República No. 7, 1st Series, 3rd Supplement, of 25 February 2003

7The Resolution No. 53/2001 of 6 November is published in Boletim da República No. 44, 1st Series, 2nd Supplement of 6 November 2001

B1.2.6 International Convention on Civil Liability for Oil Pollution Damage 1992 (1992 CLC Protocol)

This Convention provides for a compensation fund for clean-up costs and environmental damage subject to certain conditions and limits. Pursuant to Resolution No. 52/2001, of 6 November8, the Republic of Mozambique withdrew from the 1969 CLC Convention and acceded to the 1992 CLC Protocol.

B1.2.7 Other Relevant International Conventions [(9)]

Other important relevant international conventions are listed in *Table* below.

Table 2 International Conventions relevant to the proposed project

#	Convention and Description
1.	**Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention 1972), London, 1972** This Convention regulates the dumping at sea of matter scheduled in the Convention. It contains a list of prohibited substances and substances requiring permits and sets out guidelines in this regard.
2.	**Convention for the Prevention of Marine Pollution from Land-based Sources (Paris Convention), Paris, 1974** This Convention refers to the pollution of coastal waters from land-based sources.
3.	**United Nations Convention on the Law of the Sea (UNCLOS), Montego Bay, 1982** This convention is relevant as many provisions reflect customary international law. Part XII headed "Protection and Preservation of the Environment" includes provisions relating to marine pollution. As per Resolution No. 21/96, of 26 November10, the Republic of Mozambique ratified the UNCLOS.

8The Resolution No. 52/2001 is published in Boletim da República No. 44, 1st Series, 2nd Supplement of 6 November 2001

9 According to our research in respect of the International Conventions in force in the Republic of Mozambique which apply, either directly or indirectly, to the carrying out of petroleum operations in the exploration areas of Concessions M-10 and Sofala, there are several other International Conventions which do not figure in this list and which have either been ratified or acceded by the Republic of Mozambique. As you will notice, other than including the missing International Conventions, we have also inserted the reference to the statutes which published the relevant International Conventions in the Mozambican Official Gazette. Those without any reference to such a statute may or may not be applicable to the Republic of Mozambique insofar as (i) they may be awaiting publication in the Official Gazette; (ii) were accepted by the Republic of Mozambique by way of a succession notification which was not published in the Official Gazette.

10 The Resolution No. 21/96, de 26 de Novembro is published in Boletim da República No. 47, 1st Series, 6th Supplement, of 28 November 1996

#	Convention and Description
4.	**International Maritime Organization** The Republic of Mozambique signed the Convention that established the International Maritime Organization, by means of its ratification instrument, on the 17th of January 197911. The Convention that established the International Maritime Organization (IMO), at the time known as Intergovernmental Maritime Consultative Organization was adopted in March 1948 and came into force in 1958. The International Maritime Organization has the objective, inter allia, according to article 1 a): "To provide machinery for cooperation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade, and to encourage the general adoption of the highest practicable standards in matters concerning maritime safety, efficiency of navigation and prevention and control of marine pollution from ships; and to deal with administrative and legal matters related to the purposes set out in this Article". Per Resolution No. 16/83 of 9th November12, Mozambique ratified the Amendments approved by the Resolution A 358 (IX) of this Organization13. Per Resolution No. 54/2001 of 6th November14, Mozambique acceded to the Amendments to the paragraphs 16, 17 and 19 of the Convention. Per Resolution No 19/2003 of 3rd June15, Mozambique ratified the amendments to the paragraphs 11, 15, 21, 25, 56, and 57 and to the new paragraphs 47 until 51 of this Convention.
5.	**Convention on the international regulations for preventing collisions at sea (COLREGS), 1972** One of the most important innovations in the 1972 COLREGs was the recognition given to marine traffic separation schemes - **Rule 10** gives guidance to determining safe speed, the risk of collision and the conduct of vessels operating in or near traffic separation schemes. Pursuant to the Resolution No. 11/88, of 28 December16, the Republic of Mozambique acceded to the COLREGS.
6.	**International Convention for the Safety of Life at Sea (SOLAS), 1974** The SOLAS Convention in its successive forms is generally regarded as the most important of all international treaties concerning the safety of merchant ships. The first version was adopted in 1914, in response to the **Titanic** disaster, the second in 1929, the third in 1948 and the fourth in 1960. It prescribes numbers of lifeboats, other emergency equipment and safety procedures for merchant ships. Mozambique acceded to this Convention per Resolution No. 26/94 of 1st September and to the Amendments to this Convention per Resolution No. 25/2004 of 14th July17.

11Both the text of the Convention that establishes the International Maritime Organization and the Resolution that ratifies it were not published in the Boletim da República. The information that is contained in this paragraph was taken from the text of Resolution nr. 16/83 from the 9th of November that ratified the Amendments to the Convention. The International Maritime Organization recognizes Mozambique as one of the member states of the convention.

12 The Resolution No. 16/83 of 9th November is published in Boletim da República No. 45, 1st Series of 9 November 1983

13These amendments are not published in the Boletim da República and only the Resolution text is published.

14 The Resolution No. 54/2001 of 6th November is published in Boletim da República No. 44, 1st Series, 2nd Supplement of 6th November 2001

15 The Resolution No. 19/2003 of 3rd June is published in Boletim da República No. 30, 1st Series of 23 July 2003

16 The Resolution No. 11/88, of 28th December is published in Boletim da República No. 52, 1st Series, Supplement, of 28 December 1988

17 The Resolution No. 25/2004 of 14th July is published in Boletim da República No. 28, 1st Series, of 14 July 2004

#	Convention and Description
7.	**International Ship and Port Facility Security Code** (ISPS Code) The ISPS Code is implemented through chapter XI-2 Special measures to enhance maritime security in the SOLAS. The purpose of the Code is to provide a standardised, consistent framework for evaluating risk, enabling Governments to offset changes in threat with changes in vulnerability for ships and port facilities through determination of appropriate security levels and corresponding security measures. The Republic of Mozambique ratified the ISPS Code by way of Resolution No. 26/2004, of 14 July 200418.
8.	**Regional Cooperation and Coordination of Maritime Search and Rescue and Global Maritime Distress and Safety System (GMDSS) and corresponding Annex 1 that establishes Sub Regional Search and Rescue Centres, for Coastal African Countries located both in the Indian and Atlantic Oceans.** The Global Maritime Distress and Safety System (GMDSS) is an international system that uses terrestrial and satellite technology and onboard radio telecommunications to ensure a fast communication between vessels and with terrestrial authorities in case of a maritime disaster. Per Resolution No. 65/2001 of the 19th of December19, Mozambique ratified Resolution No. 1 of the Conference of the International Maritime Organization (IMO) on Regional Cooperation and Coordination of the Maritime Search and Rescue and Global Maritime Distress and Safety System (GMDSS) and corresponding Annex 1 that establishes Sub Regional Search and Rescue Centres, for Coastal African Countries located both in the Indian and Atlantic Oceans.
9.	**Convention on the International Maritime Satellite Organisation (INMARSAT), London 1976, 1985, 1989** The purposes of INMARSAT is to improve maritime communications, thereby assisting in improving distress and safety of life at sea communications, the efficiency and management of ships, maritime public correspondence services, and radio determination capabilities. The Republic of Mozambique acceded to INMARSAT and to its 1985 and 1989 amendments by way of Resolution No. 15/89, of 23 November20.
10.	**African Convention on the Conservation of Nature and Natural Resources, 1968** The fundamental principle of this Convention consists in the Contracting States undertaking of adopting the measures to ensure conservation, utilization and development of soil, water, flora and faunal resources in accordance with scientific principles and with due regard to the best interests of the people. Pursuant to Resolution No. 18/81, of 30 December21, the Republic of Mozambique acceded to the African Convention on the Conservation of Nature and Natural Resources.

18 The Resolution No. 26/2004 of 14th July is published in Boletim da República No. 28, 1st Series, Supplement of 14 July 2004

19 The Resolution No. 65/2001 of 19th December is published in Boletim da República No. 51, 1st Series, 3rd Supplement of 19 December 2001

20 The Resolution No. 15/89, of 23 November is published in Boletim da República No. 47, 1st Series, Supplement, of 23 November 1989

21 The Resolution No. 18/81 of 30th December is published in Boletim da República No. 52, 1st Series, Supplement, of 30 December 1981

#	Convention and Description
11.	**Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region, Nairobi 1985 and corresponding Protocols for protected areas, wildlife and vegetation in the East African Region and the Protocol concerning cooperation in combating marine pollution in case of emergency in the East African Region.** Pursuant to this Convention, the contracting States undertook to take the appropriate measures to maintain essential ecological processes and life support systems, to preserve genetic diversity, and to ensure the sustainable utilization of harvested natural resources under their jurisdiction and to prevent, reduce and combat pollution in the area of the Convention, originated by - discharges from vessels, - deposition of waste and other material in the sea - coastal disposal or river and estuaries discharge, costal settlements, sewage systems or other existing sources on their territories, - sea floor and sub soil exploitation, - atmospheric discharges The Contracting Parties are also obliged to pay special attention to areas with the presence of rare or fragile ecosystems, as well as rare, threatened or endangered vegetation and animal species and their habitats. The following Protocols are part of this Convention: - Protocol for Protected Areas, wildlife and vegetation in the Eastern African Region, containing a) Annex I that lists wild vegetation protected species, b) Annex II that lists animal species that need special protection , c) Annex III that lists wildlife collectable species that require protection and d) Annex IV that lists protected migratory species - Protocol for the cooperation in the combat to pollution in emergency situations in the Eastern African Region with an Annex containing the guidelines for the report to be issued in case of marine pollution incidents. The Republic of Mozambique, by way of Resolution No. 17/96, of 26 November22, ratified this convention.
12.	**Agreement related with the application of the Dispositions of the United Nations Convention on the Law of the Sea regarding the Conservation and Management of Straddling and Highly Migratory Fish Species** This agreement has the objective to ensure the long term conservation and sustainable exploitation of straddling stocks and highly migratory fish populations through the effective application of the relevant dispositions of the Law of the Sea Convention. Mozambique acceded to this Agreement per Resolution No. 19/2008 of the 16th December23.
13.	**Convention on the Conservation of the Migratory Species of Wild Animals ratified in Bona, Germany, on the 23rd of June 1979, and corresponding amendments from 1985, "1988, 1991, 1994, 1997, 1999, 2002 and 2005** This convention has the objective to predict a series of measures, including bilateral or multilateral agreements, to conserve wildlife in its innumerous forms, as it constitutes an irreplaceable element of the earth's natural systems, particularly those species of wild animals that migrate across or outside national jurisdictional boundaries The Republic of Mozambique acceded to this Convention per Resolution No. 9/2008 of 19th September24.

22 The Resolution No. 17/96 of 26th November is published in Boletim da República No. 47, 1st Series, 5th Supplement of 28 November 1996

23 The Resolution No. 19/2008 of 16th December is published in Boletim da República No. 50, 1st Series, 5th Supplement of 16 December 2008

#	Convention and Description
14.	**Protocol for the Fisheries of the Southern Africa Development Community, in annex, signed in Blantyre, on the 14th of August 2001** This Protocol has the general objective to promote the responsible and sustainable use of the living aquatic resources and aquatic ecosystems of interest to State Parties. Special attention should be given to Article 14 of the Protocol, which states that the member states are committed to the following: - Conservation of aquatic ecosystems, including their biodiversity and unique habitats, which contribute to the livelihood and aesthetic values of the people and the Region. - Apply the precautionary principle to ensure that activities within their jurisdiction and control do not cause excessive transboundary adverse impacts. - Each State Party shall in close co-operation with the SADC institutions and relevant international agencies take concerted actions to protect endangered living aquatic species and their habitats, so as to: Mozambique ratified this Protocol per Resolution No. 39/2002 of 30th April25, signed in Blantyre, 2001.
15.	**Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), Ramsar, 1971** By way of Resolution No. 45/2003, of 5 November26, the Republic of Mozambique acceded to this Convention and its associated Protocol, which focuses on the protection of wetlands. An obligation is to conserve and protect wetlands and, as such, this Convention is indirectly relevant to integrated pollution and waste management.
16.	**Convention on Biological Diversity (CBD), Nairobi, 1992** Pursuant to Resolution No. 2/94, of 24 August27, the Republic of Mozambique is a party to this Convention which obligates the protection of biodiversity and thus, indirectly, to promote environmentally sound integrated pollution and waste management practices.
17.	**Vienna Convention for the Protection of the Ozone Layer, 1985, London 1990, Copenhagen 1992 and Montreal Protocol of 1987** As per Article 2.1 of this Convention, the Parties thereto undertook the obligation to take appropriate measures to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the ozone layer. Pursuant to Resolution No. 8/93, of 8 December28, the Republic of Mozambique acceded to the Vienna Convention for the Protection of the Ozone Layer and to its 1990 and 1992 Amendments.

24 The Resolution No. 9/2008 of 19th September is published in Boletim da República No. 38, 1st Series, 3rd Supplement of 19 September 2008

25 The Resolution No. 39/2002 of 30th April is published in Boletim da República No. 17, 1st Series, 2nd Supplement, of 30 April 2002

26 The Resolution No. 45/2003 of 5 November is published in Boletim da República No. 45, 1st Series, 2nd Supplement, of 5 November 2003

27 The Resolution No. 2/94 of 24 August is published in Boletim da República No. 34, 1st Series 3rd Supplement of 24 Augusto 1994

28 The Resolution No. 8/93 of 8th December is published in Boletim da República No. 49, 1st Series, 2nd Supplement, of 8 December 1993

#	Convention and Description
18.	**Amendments of 1997 of Montreal and of 1999 Beijing to the Protocol of Montreal of 1987 about the substances that destroy the Ozone Layer** Trough Resolution No. 9/2009 of 18th September[29], Mozambique acceded to the Amendments of 1997 of Montreal and of 1999 of Beijing to the Protocol of Montreal of 16th September 1987 about the substances that destroy the ozone layer.
19.	**Basel Convention on the control of Trans-boundary Movements of Hazardous Wastes and their Disposal, 1989** This convention regulates the import, export and trans-boundary movement of hazardous waste. The Republic of Mozambique ratified the Basel Convention on the control of Trans-boundary Movements of Hazardous Wastes and their Disposal by way of Resolution No. 18/96, of 26 November[30].
20.	**Convention on the Ban of the Import into Africa and the Control of Transboundary Movements and Management of Hazardous Wastes within Africa, Bamako, 1991** During the negotiation of the Basel Convention, the African states represented by the Organisation for African Unity adopted the Bamako Convention believing that the Basel Convention was not strict enough. The Bamako Convention totally prohibits the import of hazardous waste into Africa. The Convention came into force on April 22, 1998. The Republic of Mozambique ratified the Bamako Convention by way of Resolution No. 19/96, of 26 November[31].
21.	**The United Nations Framework Convention on Climate Change (UNFCCC or FCCC) and the Kyoto Protocol, 1992 & 1997** UNFCCC is an international environmental treaty produced with the objective of achieving stabilization of greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with the climate system. The Kyoto Protocol to the UNFCCC was adopted in December 1997, whereby most industrialized nations and some central European economies in transition agreed to legally binding reductions in greenhouse gas emissions of an average of 6 to 8% below 1990 levels between the years 2008-2012, defined as the first emissions budget period. The UNFCCC was ratified by way of Resolution No. 1/94, of 24 August[32] and the Kyoto Protocol acceded to by the Republic of Mozambique by way of Resolution No. 10/2004, of 28 July 2004.
22.	**Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention), Paris, 1972** The World Heritage Convention, acceded to by the Republic of Mozambique by way of Resolution No. 17/82, of 13 November[33], aims to promote cooperation among nations to protect heritage from around the world that is of such outstanding universal value that its conservation is important for current and future generations.

29 The Resolution No. 9/2009 of 18th September is published in Boletim da República No. 37, 1st Series, 3rd Supplement, of 18 September 2009

30 The Resolution No. 18/96 of 28th November is published in Boletim da República No. 47, 1st Series, 5th Supplement, of 28 November 1996

31 The Resolution No. 19/96 of 26 November is published in Boletim da República No. 47, 1st Series, 5th Supplement, of 28 November 1996

32 The Resolution No. 2/94 of 24 August is published in Boletim da República No. 34, 1st Series, 2º Supplement of 24 of August 1994 , and the Resolution No. 10/2004 of 28 July is published in Boletim da República No. 30, 1st Series, Supplement, of 28 July 2004

33 The Resolution No. 17/82 of 13th November is published in Boletim da República No. 44, 1st Series, Supplement, of 13 November 1982

B1.3 NATIONAL LEGAL FRAMEWORK

The essential Ministerial Diplomas for environmental management in Mozambique are the following:

- Resolution no 5/95, of 3rd March (Approves the Environmental National Policy);
- The Environmental Law (Law No. 20/97 of 1st October);
- EIA Regulations (Decree no. 45/2004, 29th September – Regulation on Environmental Impact Assessment Process) altered by Decree No. 42/2008 of 4th November, and by Dispatch of 5th March of 2008 including the General Directives for Environmental Impact Assessment (Ministerial Diploma No. 129/2006 of 19th July) and for the Public Participation Process in the Environmental Impact Assessment (Ministerial Diploma No. 130/2006 of 19th July);
- Regulations on Environmental Quality and Effluents Emission Standards (Decree No. 18/2004 of 2nd July);
- Regulations for the Environmental Audit Process (Decree No. 32/2003 of 12th August);
- Regulations for the Environmental Inspection (Decree No. 11/2006 of 15th June)

For the sectorial (petroleum industry) environmental management the most relevant diplomas are:

- Petroleum Law (Law No. 3/2001 of 21st February*);*
- Regulation on Petroleum Operations (Decree No. 24/2004 of 20th August*);*
- Regulations for the Prevention and Protection of the Marine and Coastal Environment (Decree No. 45/2006 of 30th November*);*
- Law of the Sea (Law No. 4/96 of 4th January);
- Law No. 10/99, of 7th July (Forestry and Wildlife Law – protects certain marine species);
- Decree No. 51/99, of 31st August (Regulations on Recreational and Sport Fishery).

B1.3.1 Petroleum Activities

As per Article 98.1 of the 2004 CRM, the natural resources located within the territory of Mozambique are exclusively owned by the Republic of Mozambique. Pursuant to Article 102 of the same statute, the State promotes the evaluation of its natural resources and determines their use and exploitation conditions in compliance with the country's interests.

The Petroleum Law

The Law34 preamble highlights that "petroleum resources are assets whose proper exploitation can contribute significantly to national development."

The Petroleum Law establishes the legal requirements for operations in the Petroleum Sector, defined as the operations related to survey, development, production, separation and treatment, storing, transport and sales or delivery of petroleum products to an agreed supply point. This includes natural gas processing operations and the decommissioning of all the completed operations.

- Article 23 of this Law deals specifically with "environmental protection and security" imposing an obligation on licence holders (and other operators) to ensure that it will not result in an ecological damage caused by petroleum operations. When unavoidable, internationally accepted norms must be observed. If an activity is deemed to potentially cause a risk of this nature, it is necessary to conduct and submit to the appropriate authorities an Environmental Impact Assessment that includes proposed mitigation measures;

- Avoid the destruction of the soils, water table, crops, building structures, and other infrastructures and goods;

- Clean up sites following completion of petroleum operations and implement environmental rehabilitation requirements.

Article 23.2 of the Petroleum Law requires the petroleum operations license holder to devise an appropriate management plan for polluted waters and for petroleum waste products that applies approved methods.

The POR specify environmental requirements, which among others, includes the obligation to identify, evaluate and mitigate potential environmental impacts originating from the surveys associated with Petroleum Operations.

The Survey Plan must be presented to the National Petroleum Institute five (5) weeks prior to the start of the activities and shall include an Environmental Impact Assessment (Article 26).

Article 90 of POR lists the environmental issues to be considered in conducting activities related to Petroleum Operations.

Petroleum Operations Regulations

The Petroleum Operations Regulations35 were approved in August 2004 in order to define the types, terms and conditions of contracts, the petroleum operations'

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34 The Petroleum Law is published in the Boletim da República No. 8, 1st Series, Supplement, of 21 February 2001.

practices, including the management of resources, safety, health and environmental protection, as well as the submittal by the holders of rights to conduct petroleum operations of plans, reports, data, samples and other information.

According to article 3 of the same decree, Petroleum Operations are carried on the basis of a concession contract which may be of:

- Survey;
- Exploration and production; and
- Construction and operation.

These contracts are defined in articles 12, 13 and 14, of Petroleum Law.

According to Article 27 of these Regulations, the Operator shall report any discovery, within 24 hours of its detection, to the National Petroleum Institute, and keep said institute informed in regard of the test results and their evaluation of the discovery, which includes drilling activities.

According to the Terms of Reference for this study, one of the objectives of the drilling in Area 4 is to determine the existence or not of petroleum in commercial quantities.

Now, the Petroleum Operations Regulations stipulate in Article 28 that the Operator shall undertake the technical and commercial evaluation necessary to conclude whether a discovery may be commercially developed and shall submit, within one year, an appraisal report. This report shall be submitted to the Minister with authority over the petroleum industry, informing him if the petroleum deposits covered by the discovery may be commercially developed, and such notice shall include a declaration of commerciality comprising a complete description of the relevant data, surveys and evaluations which led to such conclusions.

Only on the basis of the submission of the report it can be concluded that the petroleum deposits covered by the discovery may be commercially developed.

The corresponding notice submitted by the Operator will be deemed as a Declaration of Commerciality and on the basis of this Declaration the Government will decide whether it will exercise or not the right to participate in the development and production of the petroleum deposits, for which purpose the Minister with authority over the petroleum industry may request additional information and clarifications from the Operator.

Should the Operator consider the petroleum deposits comprised by the discovery unsuitable for a practicable commercial development, the commerciality report shall address the necessary measures to render their development commercially

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35 The Petroleum Operations Regulation Decree No. 24/2004 is published in the Boletim da República No. 33, 1st Series, 2nd Supplement, of 20 August 2004

practicable and propose additional tasks for the evaluation of the commerciality of said deposits.

Finally, in the case a discovery is commercially developed, Article 30 establishes that the Operator must prepare a Development Plan, programming the Development and Production of the corresponding Petroleum Deposits for a period of two years as of the date of the Declaration of Commerciality. The Development Plan must include the Environmental Impact Assessment (j).

Article 75 provides the general requirements for drilling and other well operations:

1. Drilling and well activities shall at all times be carried out in a safe and proper manner, i.e.:
    a) Measures shall be taken to ensure regularity and prevent the interruption of operations;
    b) Operating and maintenance procedures shall take due consideration of relevant equipment specifications such as their pre-determined operating and maintenance limits;
    c) Operational measures shall be taken to prevent fires, explosions, pollution, or any sort of damages;
    d) Well casing shall be conceived and developed so as to render the well under control at all times;
    e) Safety equipment for drilling shall be installed in accordance with the requirements of the planned activities and with these Regulations;
    f) The ground or seabed shall be examined prior to drilling or prior to the installation or setting up of well facilities so as to ensure that the external environment will not cause damage to existing facilities;
2. The Operator shall:
    a) Establish plans and procedures for drilling and simultaneous operations on wells;
    b) Identify, by means of risk analysis, situations where well control may be lost or other hazardous situations that may occur as a result of simultaneous activities;
    c) Establish the operational limits applicable to drilling and well activities undertaken within the same facility;
    d) In accordance with the established procedures, shut down wells in areas where falling objects are capable of causing damages thereto.
3. Prior to drilling and well activities, the Operator shall:
    a) Develop an Emergency Plan for the cases of a Blow out of oil, gas or water, and that identifies suitable locations for drilling of a relief well;
    b) Develop a plan for the mobilization and organization of personnel in the event of a blowout. This shall also include all the equipment and services which are required for the drilling of the exploratory well and a potential relief well, as well as for the control of an erupting relief well, including possible direct intervention.

Article 77 provides Operation Requirements, including:

a) In accordance with safety and operational criteria, oil based and synthetic oil based drilling fluids shall only be used when such is required;
b) Fluid volumes shall be verified prior to, during and subsequent to the removal of equipment from the well. Procedures shall be established to remove the unintentional influx of fluids from the well, as well as to maintain pressure control in the event of their loss;
c) Formation testing including drilling, hydraulic fracturing, acid treatment or other physical or chemical treatment of the well shall be done according to requirements in these Regulations and with best practices of the Petroleum Industry;
d) Well control equipment shall be periodically tested and examined under pressure so as to verify that its barrier functions;
e) Prior to temporary or permanent plugging of a well is carried out, the zones with flow potential shall be located so as to prevent the eruption of hydrocarbons and other formation fluids.

Article 82 refers to hazardous material management:

a) Transport, storage and use of hazardous material shall take place in a controlled manner and in accordance with national legislation, as well as internationally accepted rules and principles, for which purpose documented rules and procedures of their handling shall be made available;
b) The danger of chemical exposure involving health hazards shall be minimized in the storage, use, handling and disposal of chemicals, as well as in work operations or processes which produce chemical substances. Chemicals hazardous to health shall be classified, labelled and identified in accordance with internationally accepted standards;
c) If chemicals are moved into other containers or appliances, it must be ensured that the contents are labelled and clearly identified so as to allow the identification of their contents by personnel, of which hazards are connected with the use of such chemicals, and of which safety precautions should be taken. Prior to the use of chemicals hazardous to health, a table of instructions, regarding the applicable safety rules of such substances, shall be available at the work site;
d) Personnel shall wear individual protective equipment against risks which may not be otherwise avoided or limited to an acceptable extent. Use of radioactive substances shall be restricted on a need of use basis.

Article 86 provides general Emergency and Contingency Requirements, which include:

a) The Operator shall be prepared to handle accidents and emergencies which may lead to loss of life, injuries, pollution or major damage to property;
b) The Operator shall take the necessary measures to prevent or minimize harmful effects of accidents and to restore the environment in accordance with a Contingency Plan which shall identify the potential accident events and consequences of such events.

Article 87 refers that the Operator shall submit to the National Petroleum Institute a Contingency Plan for handling accidents and hazardous situations which may occur during Petroleum Operations and provides the contents of such a plan. It also states that the National Petroleum Institute shall be notified prior to the carrying out of emergency exercises and shall receive a report on such emergency exercises.

Article 88 indicates that the National Petroleum Institute may require the installation of emergency equipment such as fire-fighting equipment, oil barriers, vehicles, standby boats or aircrafts near or at the facilities or at major equipments involved in Petroleum Operations and stipulate the operational requirements of each of such equipment under these circumstances.

Article 89 deals with the issue of Health, Work Environment and Safety and stipulates that the operators shall promote a high level of safety and establish overall safety and work environment objectives for the specific phases of Petroleum Operations and that the operators and their contractors shall establish safety and work environment requirements for Petroleum Operations.

Article 90 of the Regulations deals specifically with the environment and requires the operators to comply with the following requirements:

- Environmental impact assessments, including impact reduction measures, shall be carried out in all areas which may be affected by Petroleum Operations.
- Registration of all environmental aspects influenced by the Petroleum Operations shall be created and maintained for all phases.
- The Operator shall prevent:
  - Accidents and material damage resultant from its activities and from the facilities' operation;
  - Damage or risk of damage to third parties' personnel and assets;
  - Damage to animals, vegetation, marine life and monuments;
  - Sea pollution and of water fountains discovered in the course of Petroleum Operations;
  - Air pollution; and
  - Damage in petroleum reservoirs.
- The Operator shall monitor and reduce the effect of all operational and accidental discharge, handling of waste and pollution emissions into the air, sea, lakes, rivers, and soil. Operational discharges shall be within the limits defined by the entity with authority over environmental matters.
- The Operator shall inform the National Petroleum Institute of the amount of operational and accidental discharges, leakages and waste and such information shall be made public.
- The Operator shall take remedial measures and repair damage to the environment when the Petroleum Operations are carried out endanger the physical safety of persons or property, or cause pollution or other environmental damage harmful to persons, animals, marine life, monuments or vegetation.
- Preferential treatment shall be given to materials and chemicals least dangerous to health and of greater safety so as to minimize the risk to persons, to the environment and to the facilities. The recycling of materials and chemicals shall be duly taken into account.

- The operator shall take due consideration of the health of personnel, as well as of the qualification and requirements applicable to medical staff. Health related aspects shall include, *inter alia*, the following:
  - Health service;
  - State of readiness in respect of health care and health services;
  - Transport of sick and injured personnel;
  - Hygienic aspects; and
  - Supply of drinkable water, catering and distribution of food supplies.
- A system of safety delegates and a work environment committee for each facility shall be established.

It should be highlighted that the Council of Ministers has recently approved (August 2010) the new Regulations on the Environmental Impact of Petroleum Operations. These regulations may only be applied after they are published in the Boletim da República.

B1.3.2 Environmental Legal Framework

The 2004 CRM defines the right of all citizens to live in a balanced natural environment and their obligation to protect it (Article 90). Furthermore, the State is required to (i) promote initiatives capable of ensuring the ecological balance and the preservation of the environment; and (ii) implement policies to prevent and control pollution and to integrate environmental objectives in all public sector policies so as to guarantee the citizens' right to live in a balanced environment under a sustainable development framework (Article 117 of CRM).

The National Environmental Policy, approved by Resolution No. 5/95, of 6 December36, laid the foundations for all ancillary environmental legislation. As per its Article 2.1, the main purpose of said policy consists in ensuring a sustainable development by way of undertaking an acceptable compromise between the country's socio-economic development and the protection of the environment. For the aforesaid purpose, such policy shall ensure, inter alia, the management of the country's natural resources - and of the environment in general -, so that such resources preserve their functional and productive capacities for present and future generations.

The Environment Law (Law No. 20/97, of 7th October37) defines the legal basis for the sound use and management of the environment as a means to safeguard sustainable development in the country. The Law applies to all activities in the public or private sectors that may directly or indirectly affect the environment.

Relevant core principles for environmental management contained in the National Environmental Policy and in the Environment Law include:

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36 The Resolution No. 5/95 of 3rd August is published in Boletim da República No. 49, 1st Séries, Supplement of 6 December 1995

37 The Law No. 20/97 of 1st October is published in Boletim da República No. 40, 3rd Supplement of 7 October 1997

- Management of the environment so that it improves citizens' quality of life and protects biodiversity and ecosystems;
- Recognition of and valuing local communities' traditions and knowledge;
- Prioritization of systems that prevent environmental degradation;
- A holistic and integrated perspective of the environment;
- The importance of public participation;
- The principle of polluter-pays;
- The importance of international co-operation in ensuring appropriate environmental management;

As per Article 8 of the Environment Law, the Government of Mozambique (GOM) is required to create adequate mechanisms for public participation in environmental management, from the drafting of environmental policies and legislation to their implementation.

Article 9 of the same law proscribes the production and deposit of any toxic and polluting substances in the nation's soils, sub-soils, water or the atmosphere, and prohibits the undertaking of activities likely to accelerate erosion, desertification or any other form of environmental degradation beyond the legally established limits.

B1.3.3 Environmental Impact Assessment

According to the Environment Law, the Environmental Impact Assessment (EIA) is an instrument to assist GOM in decision making regarding the issuing of environmental licenses for development projects. The issuing of an environmental license shall precede any other required legal licenses.

The EIA Regulations, approved by Decree No. 45/2004, of 29 September38, are applicable to all activities in the public and private sectors. Article 2.2 of said Decree envisages the creation of specific legislation for the petroleum sector, legislation which at the time of writing of this report had not yet been approved.

An important step in the EIA process is environmental screening, which defines the extent and type of environmental assessment required for any given project.

As also prescribed in the World Bank Environmental Assessment Guidelines, the Mozambican EIA Regulations (Article 3) employ three project categories to identify the appropriate level of environmental assessment (EA), namely:

- Category A: projects that could have significant impacts due to the nature of the proposed activities or the sensitivity of the area, requiring a full EIA (including EMP); An Annex of the EIA Regulations lists the types of projects classified as Category A projects.

38 The Decree No. 45/2004 of 29th September is published in Boletim da República No. 39, Supplement of 29th September 2004

- Category B: corresponds to projects that would have negative impacts with lower duration, intensity, extension, magnitude and/or significance, requiring a Simplified EA.
- Category C: refers to projects that do not require any EA.

In terms of the EIA regulation, exploration well drilling and well testing activities in Block M-10 are classified as Category A activities and are subject to a full EIA. Relevant criteria for this classification under Decree No. 45/2004 include:

- The activities will also take place near the mangrove areas at the mouths of the Pungue, Buzi, Save and several other rivers;
- The activity will take place in close proximity to the Sofala Bank, considered as one of the most important fishing grounds of Mozambique for both industrial and artisanal fishermen;
- The activity will take place in close proximity to a prawn aquaculture project;
- There will be a potential impact on the livelihoods of local communities; and
- The activities will involve the exploration for hydrocarbon derivatives.

In accordance with EIA Regulations, there are three distinct steps to carrying out an EIA for a Category A Project:

1. Registering the EIA with MICOA ("Instrução do processo");
2. Preparation of an Environmental Pre-feasibility and Scope Definition Study (EPDA) ("Estudo de Pré-viabilidade Ambiental e Definição de Âmbito") and Terms of Reference for the EIS;
3. The EIS Study, *per se* (including the Impact Assessment and the Public Consultation).

Registration of the EIA

In the first instance the proponent must register the project with MICOA in order for the project to be classified (Category A, B or C).

The documentation for registering the EIA with MICOA is as follows:

- Descriptive Memoir;
- Description of the activity;
- Justification for the Activity;
- Legal framework;
- Summary bio-physical and socio-economic description of the area;
- Resource use in the area;
- Information about the environment in the area of the proposed activity;
- Information about the EIA steps, i.e. production and submission of the Terms of Reference (TOR), EPDA (Environmental Pre-feasibility and Scoping Study (EPDA); and
- Preliminary Environmental Information Form (available at the National Directorate for Environmental Impact Assessment).

Environmental Pre-feasibility and Scoping Study (EPDA) and TOR

Upon confirmation from MICOA that a project is classified as a Category A the proponent must prepare an Environmental Pre-feasibility and Scoping Study Report and prepare TOR for the EIS.

The EPDA Report contains as a minimal the following information:

- Non-technical Summary, including the main issues addressed, as well as conclusions and recommendations;
- Identification and address of the Proponent and the multi-disciplinary team responsible for conducting the EIS;
- The limits of the indirect influence area of the activity and land use patterns in the direct and indirect influence areas;
- Description of the activity and the anticipated actions, as well as the respective alternatives in planning, implementation and operation (or deactivation, in case of temporary activities);
- Biophysical and socio-economic description of the area;
- Identification and evaluation of any potential fatal flaws of the activity;
- Identification and description of the issues to be addressed in detail in the EIS; and
- Detailed Terms of Reference for the EIS in accordance with the EIA Regulations.

Environmental Impact Assessment

Upon approval of the EPDA and TOR for the EIS by MICOA, the proponent may proceed with the EIA, *per se*.

Article 12 of the EIA Regulations stresses that the project proponent is entirely responsible for the undertaking of the EIA process. The resulting EIS must contain, at a minimum, the following:

- A non technical project summary of the main issues, conclusions and proposals;
- The legal framework governing the activity and its integration in the existing local development plans in the direct influence zone of the project;
- A description of activities to be developed and the different actions foreseen in the planning and construction, exploration, and in case of a temporary activity, the decommissioning phases;
- A general description of the environmental situation of the project area and its geographical representation and boundaries;
- A description and comparison between the different alternatives and the prediction of the future environmental situation with or without

mitigation measures;

- Identification and assessment of impacts and indication of mitigation measures to be adopted to minimize/eliminate the negative social and environmental impacts resulting from the development of such activity;
- The Environmental Management Plan for the Activity, which includes the monitoring of impacts, an environmental education program and contingency plans in case of accidents;
- Identification of the multidisciplinary team that undertook the EIA;
- The Public Participation Report as stipulated in Article 14.9.

The Public Participation Process is a compulsory activity for all Category A Projects. Article 14 of the EIA Regulations defines the Public Participation Process as an activity which involves public auscultation and consultation. The Public Participation Process implies delivery of information regarding projects to all directly and indirectly affected and interested parties, responding to public requests for explanations on the project and the formulation of suggestions regarding the project.

The Guidelines for Public Participation are further defined in the General Directive for the Public Participation Process in the Environmental Impact Assessment Process.39

Deadlines to inform about decisions

The Environmental Impact Assessment Authority must comply with the following deadlines:

- Pre-assessment – up to 5 working days;
- EPDA and ToR – up to 30 working days;
- Environmental impact study – up to 45 working days.

Fees for environmental licensing

According to Decree 42/2008 of 4th November40, for environmental licensing for a Category A Project a fee of 0.2% of the investment is applied and is payable to the Ministry of Finances.

Environmental Auditing

The Environmental Audit (EAUD) Regulations, approved by Decree No. 32/2003, of 20th August41, define the environmental audit as both a management instrument and

39 The Ministerial Diploma No. 130/2006 of 19th July is published in Boletim da República No. 29, 1st Series, of 19 July 2006

40 The Decree No. 42/2008 repeals some articles of Decree No. 45/2004 of 29th September, including Article 25 which presents the fees.

one of systematic, documental and objective assessment of the functionality and organisation of the control and protection of the environment.

Pursuant to Article 3 of the EAUD Regulations, the environmental audit is either public or private. In accordance with said provision, the environmental audit of private sector activities is carried out by the entities whose activities have the potential to cause environmental damage. In accordance with Article 7 of said statute, the purpose of the environmental audit is to assess compliance of the functional and working processes of such enterprises with respect to the approved environmental management plan and with all environment related legislation.

Environmental Inspection

The Decree No. 11/2006 of 15th June42 approved the Regulations on Environmental Inspection.
This Regulation is aimed at establishing legal mechanisms for inspection of activities undertaken by the public and private sectors, which are likely to directly or indirectly cause negative impacts on the environment.

According to Article 2 of the regulation, Environmental Inspection includes:

- Inspection of auditing and environmental monitoring activities, verifying if the recommendations of environmental audits have been applied or if not, the current state of the environment.

- Inspection of compliance in the implementation of mitigation measures proposed in the scope of the environmental impact assessment process with a view to reducing or eliminating the negative impacts of any activity on the environment.

The regulation distinguishes two types of environmental inspections namely: Ordinary Inspection, when undertaken within the scope of implementation of the activities of the MICOA, and Extraordinary Inspection, when undertaken regarding the achievement of objectives related to any public or private activity that is likely to have a negative impact upon the environment.

B1.3.4 Other Environmental Legal Considerations

The Sea

Maritime activities assume a relevant category in the political, economic and social context of Mozambique. The Law No. 4/96, of 4 January43 – the Law of the Sea -

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41 The Decree No. 32/2003 of 12th August is published in Boletim da República No. 34, 1st Series of 20 August 2006
42 The Decree No. 11/2006 of 15th June is published in Boletim da República No. 24, 1st Series, Supplement, of 15th June 2006

defines the limits of the Mozambican territorial sea and of its exclusive economic zone (EEZ), within which the Republic of Mozambique has exclusive rights to the exploitation, conservation and management of resources.

As per Article 9 of the Law of the Sea, the EEZ of the Republic of Mozambique is of 200 miles from the territorial sea, which in turn is roughly defined as being of 12 miles from the coast line (Article 4).

Within the EEZ the government has sovereign rights to exploration, conservation and management of resources within this area including the subsoil, as well as any other economic activities including energy production from water currents and wind (Article 11).

With reference to sea water quality, Decree No. 45/2006 of 30 November44 approved the Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment. It repeals Decree No. 495/73, of 6 October and forbids the disposal of any substance that may pollute the water and beaches, including pollution by hydrocarbon products.

As established in its article 2, the objective of this Regulation is to determine the appropriate measures to prevent and limit pollution resulting from illegal discharges carried out by ships, platforms or by land-based sources, off the Mozambican coast as well as the establishment of legal bases for the protection and conservation of the maritime, lacustrine and fluvial public domain areas, of beaches and of fragile ecosystems.

The Regulation applies to all national or foreign natural or legal persons, performing activities susceptible of causing negative impacts on the environment, in maritime, lacustrine and fluvial public domain areas, including all fragile ecosystems bordering the coast and inland waters (art. 3).

In addition, the Regulation applies to discharges of harmful or dangerous substances by ships, in ports, harbour facilities, emission facilities along the coast, platforms or by other land-based sources, namely:

a) In inland waterways, including ports and wetlands;
b) In the territorial waters of the Mozambican State;
c) In the Mozambique Channel, when used for international navigation subject to the transit passage regime, established in Part III, Section 2, of the Convention of the Law of the Sea, ratified by Resolution 21/96, of 26th November, insofar as the Mozambican State exercises jurisdiction over the Channel;

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43 The Law No. 4/96 of 4th January is published in Boletim da República No. 1, 1st Series, Supplement of 4 January 1996

44The Decree No. 45/2006 is published in the *Boletim da República* N.º 48, 1st Series, Supplement of 30th November 2006

d) In the exclusive economic zone, established in agreement with international law; and
e) In the international waters.

The regulation also applies to all domestic and foreign ships navigating the jurisdictional waters of the Republic of Mozambique as well as to facilities situated off the Mozambican coast, regarding any discharge or dumping occurred under its terms
(art. 3, no. 3).

Regarding the classification of harmful or dangerous substances, the Regulation refers to the waste management legislation in force 45.

Heading II of this Regulation deals with ships and platforms.

In the scope of pollution prevention and control systems, the Regulation stipulates that all ports, port facilities, platforms, emission facilities along the coast as well as their support facilites, have the obligation to have adequate facilities or means for the collection and treatment of the various types of waste and for pollution control at their disposal. (art 5, no. 1).

Their owners must prepare a procedures manual for the management of the various types of waste produced by or deriving from the movement and storage of oil and harmful or dangerous substances. This procedures manual shall be approved by the entity supervising the area of the environment. The owners must also have contigency plans available for fighting oil pollution and pollution by harmful or dangerous substances46.

Ships have furthermore the obligation to store all waste produced onboard, before leaving the port, respecting, however, the conditions under which this may not be done47.

The Regulation also stipulates the obligation to provide a waste record book 48.

In Chapter II (articles 11 to 14), the Regulation deals with issues related to the transport of oil, hydrocarbons and harmful or dangerous substances, stipulating obligatory Record Books and the data that should be entered, and the obligation to

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45 Article 3 of the Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment
46 Articles 5, 6 and 7 of the Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment
47 Article 8 of the Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment
48 Article 9 of the Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment

inform about their onboard location as well as the data that the packing of harmful or dangerous substances should provide.

Chapter III (Articles 15 to 25) deals with aspects related to oil and harmful or dangerous substance discharges, prohibiting their occurrence in waters of national jurisdiction, and defines the exceptions to this prohibition. Chapter III also includes the obligation to communicate incidents occurring in ports, ships, platforms and support facilities liable to cause pollution of waters of national jurisdiction.

Article 20 indicates that the discharge of solid waste from the drilling activities are subject to specific regulations from MICOA in Coordination with INAMAR and the Ministry of Mineral Resources. These regulations have still not been prepared.

Furthermore, in Chapter III the obligation is laid down to communicate incidents occurred in ports, ships, platforms and support facilities liable to cause pollution of waters of national jurisdiction.

Chapter IV (articles 26 to 32) defines the competences of the maritime authority to avoid pollution, among which the possibility to demand that the ship master and/or owner:

a) Carry out transshipment to another ship available or discharge to a specific part of the same ship or to a port depot, within a given time frame;
b) Move the ship under his command to a specific location;
c) Retain the ship at a given location, until a contrary order is given according to the ship's specific conditions and its current position;
d) Abstain from any unloading or transshipment of hydrocarbon or part of it until a contrary order is given by the maritime authority;
e) Carry out operations for sinking or destroying the ship or its load or part of it, in agreement with Government decisions;
f) Follow a given route, in the event that the ship is navigating in territorial waters or in the contiguous zone;
g) Seek to obtain help from one or more vessels adequate to support the maritime authority in the measures that turn out to be necessary;
h) Take other measures in relation to the ship or its load to impede the hydrocarbon discharge or the continuation of this discharge

Regarding facilities' masters, the maritime authority may demand the suspension of the facilities' operation or that the above-mentioned measures are taken.

Chapter V (articles 33 to 42) deals with the investigation of incidents, sanctions and compensation for damages.
In addition to the pecuniary sanctions, the Regulation stipulates other punitive measures, particularly the seizure of the ship and the product's destruction or rendering it unusable.

Heading III (articles 43 a 86) of this Regulation deals with the prevention of marine and coastal pollution by land-based sources.

The Regulation has an Annex, consisting of a reference summary of the 73/78 Marpol Convention Rules with respect to oil and harmful liquid spills.

Additionally, the Regulations on Environmental Quality and Effluent Emissions Standards (Emissions Standards Regulations), approved by Decree No. 18/2004, of 2 June49, define that:

- The final disposal of industrial liquid effluent must be carried out by appropriate means. The location of the emission point or effluent discharge must be determined during the environmental licensing process with a view to ensuring the preservation of the water quality of the receiving body. The final effluent must meet discharge standards, and take into account the sensitivity and the use of the receiving body (Article 16).
- The discharge of pollutants or liquid effluent that can potentially affect bathing areas must be controlled on the basis of sanitary quality monitoring of the respective waters and beaches. Bathing must be halted whenever the water quality poses a risk to the health of the water users (Article 17).

Article 12 (water quality parameters) defines water quality for recreational purposes (swimming, water skiing, and diving):

- Null of chlorine, odor, taste and turbidity;
- Total bacteria <1,000/100 ml; and
- Coliforms <100/100 ml.

Article 16 refers to the discharge of industrial liquid pollutants or effluents into the marine environment stating that "the discharge of effluents into the ocean shall obey the standards established in Appendix V of the Regulation."

Water Resources

Water resources management in Mozambique is defined by the National Water Policy, approved by Resolution No. 46/2007 of 21st August50, and by the Water Law - Law No. 16/91, of 3 August51.
As per Article 18 of the Water Law, the Regional Water Administration bodies (ARAs) are the institutions responsible for managing the water resources comprised in the river basin for which they are regionally responsible.

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49 The Decree No. 18/2004 of 2nd June is published in Boletim da República No. 22, 1st Series, Supplement of 2 June 2004
50 The Resolution No. 46/2007 of 21st August is published in Boletim da República No. 43, 1st Series, 5th Supplement of 30 October 2007
51 The Law No. 16/91 of 3rd August is published in Boletim da República No. 31, 1st Series, 2nd Supplement of 3 August 1991

The influence zone of the Project is under the jurisdiction of ARA-Sul.

The Water Law defines the basis for water resources management, the "user pays" and "polluter pays" principles and the regime governing water use concession and licenses. These factors are defined based on environmental sustainability principles.

Article 54 of the Water Law, foresees the enactment of a regulation on effluent quality standards for receiving water bodies, treatment technologies, systems and methods ~~This regulation is~~ also foreseen in the Environmental Law and were approved by the Decree No. 18/2004 of 2nd June[52].

The water standards for human consumption are contained in the Regulations on Water Quality for Human Consumption, approved by Ministerial Diploma No. 180/2004, of 15 September[53].
These Regulations are applicable to potable water supply systems for human consumption, including surface and ground water used for direct consumption or for the production of water for human consumption. The Ministry of Health is the authority responsible for ensuring quality control of water for human consumption.
Table 3 Water quality Standards for human consumption supplied by public water sources without treatment.

Parameter	**Maximum Levels**	**Units**
1- Microbiologic parameters		
Total Coliforms		NMP*/ 100 ml Nº de Counts / 100 ml
Faecal Coliforms	0-10	NMP*/100 ml Nº de Counts / 100 ml
Cholera vibrio	Absent	1000 ml

*(NMP): More Probable Number

2- Physical and Organic Parameters		
Colour	15	TCU
Smell	Inodorous	
Conductivity	50-2000	µhmo/cm
PH	6,5 - 8,5	
Taste	Tasteless	
TSS	1000	mg/l
Turbidity	5	NTU

3- Chemical Parameters		
Ammonium	1,5	mg/l
Arsenic	0,01	mg/l
Antimony	0,005	mg/l
Barium	0,7	mg/l
Boron	0,3	mg/l
Cadmium	0,003	mg/l
Calcium	50	mg/l

52 The Decree No. 18/2004 of 2nd June is published in Boletim da República No. 22, 1st Series, Supplement, of 2 June 2004

53 The Ministerial Diploma No. 180/2004 of 15th September is published in Boletim da República No. 37, 1st Series of 15 September 2006

Parameter	Maximum Levels	Units
Lead	0,01	mg/l
Cyanide	0,07	mg/l
Chlorates	250	mg/l
Copper	1,0	mg/l
Chromium	0,05	mg/l
Total Hardness	500	mg/l
Phosphorous	0,1	mg/l
Total Iron	0,3	mg/l
Fluorite	1,5	mg/l
Organic Matter	2,5	mg/l
Magnesium	50	mg/l
Manganese	0,1	mg/l
Mercury	0,001	mg/l
Molybdenum	0,07	mg/l
Nitrite	3,0	mg/l
Nitrate	50	mg/l
Nickel	0,02	mg/l
Sodium	200	mg/l
Sulphate	250	mg/l
Selenium	0,01	mg/l
Total Solids	1000	mg/l
Zinc	3,0	mg/l
Total Pesticides	0,0005	mg/l

Regulations on Environmental Quality and Effluents Emission Standards approved by Decree No. 18/2004 of 2nd June[54]

Atmospheric Emissions and Air Quality

Article 9.1 of the Environment Law prohibits the release of any polluting and toxic substances to the atmosphere beyond the legally established limits. The Emissions Standards Regulations defines the pollutants' threshold parameters as well as core parameters which characterize air quality.

With regards to mobile emission sources, the regulation defines maximum emissions for the different categories of vehicles, assuming fuel consumption as shown in the relevant table of Annex II of said statute (*Table 1*). The Regulations do not define the emissions limit for lead (Pb), although most vehicles in Mozambique still use leaded petrol.

54 The Decree No. 18/2004 of 2nd June is published in Boletim da República No. 22, 1st Series, Supplement, of 2 June 2004

Table 1 Maximum atmospheric pollutant emissions limits allowed for mobile emission sources or vehicle

Vehicle type	Fuel consumption assumed (km/liter)	CO_2	NOx	SQOVNM	CO	N2O	Particles	Lead
Passenger vehicles	5,1	3188	6,05	3,09	6,29	0,08	0,06	
Diesel vehicles	4,3	3188	7,17	4,11	7,96	0,08	0,10	
Heavy Diesel Trucks	2,2	3188	42,86	7,63	21,80	0,08	0,26	
Motorcycles	12,8	3172	32,30	11,1	40,5	0,08	5,6	

Table 5 below, shows the air quality standards stipulated in the Emissions Standards Regulations. The Regulations regard these as the thresholds necessary to maintain the quality of self purified air and causing no significant negative impact on public health or on the ecological balance.

Table 5 Air Quality Standards

Parameters (μg/m³)	**Sampling Time**							
	1 hour		8 hours		24 hours		Yearly average	
	Primary	Secondary	Primary	Secondary	Primary	Secondary	Primary	Secondary
Sulphur Dioxide (SO_2)	800	-		-	365	-	80	-
Nitrogen dioxide (NO_2)	400	-		-	200	-	100	-
Carbon monoxide (CO)	40,000	-	10,000	-		-		-
Ozone (O_3)	160	-	-	-	50	-	70	-
TSP (total suspended particles)	-	-	-	-	200	-		-
Lead (Pb)	3	-	-	-	-	-	0,5-1,5	-

Article 22 of the Emissions Standards Regulations provides for the possibility of extraordinary pollutant emissions to the environment as a result of system failure or any other unforeseen circumstance and requires a special authorization to be issued by MICOA for said purpose, as well as the payment of a fee determined in accordance with circumstances detailed in Article 23.

With regards to noise, Article 20 of the Emissions Standards Regulations establishes that noise emission standards shall be approved by MICOA (at the date of writing of this report, these standards had not yet been published). The same Article envisages that noise emission standards will take into account the emission sources.

Solid waste management

As stated above, the Environment Law prohibits the disposal of pollutants in soils or sub-soils and the release of pollutants to the atmosphere or in water bodies beyond legally established limits. Article 9.2 of said law also prohibits the import of hazardous waste to Mozambican territory. In addition, the Water Law, prohibits the accumulation of solid wastes or any substances that contaminate or are likely to contaminate water resources (Article 53).

To date, existing legislation governing solid waste management is governed by the Waste Management Regulations approved by the Decree No. 13/2006 of 15th June55[8]. The purpose of these regulations is to provide guidance concerning the disposal on soil and subsoil, throwing to water or releasing to the atmosphere any toxic or polluting substances as well as practicing polluting activities which could accelerate impairment of the environment in order to prevent or minimize their negative impacts on health and the environment.

The regulations describe the competencies of the Ministry for the Environmental Coordination (MICOA) who is responsible for the implementation thereof. The regulations require waste to be classified in terms of its characteristics depicted in Appendix III and IV. Waste generators must prepare and submit for approval to MICOA waste management plans before any activity commences. Micoa will issue a waste management licence for the activity which is valid for a period of 5 years after which it needs to be reviewed. Applications for renewal must be submitted at least 180 days before the expiry date of the licence.

However, entities producing and handling waste are, in general, required to56:

a) Minimize the production of waste of any category;

b) Guarantee the separation of the different categories of waste;

c) Guarantee the treatment of the waste before its disposal;

d) Ensure the protection of all workers involved in waste handling against accidents and diseases resulting from their exposure;

e) Guarantee that all waste to be transported holds a minimum potential contamination risk to the workers involved in this process, to the general public and to the environment;

f) Train their workers in the field of occupational health and safety and the environment;

g) Guarantee that the elimination of waste within and outside the production site does not have a negative impact on the environment or on public health and safety;

h) Carry out an annual meticulous registration of the origin, quantities and types of waste handled, transported, treated, recycled or eliminated and retain the records during 5 (five) years following the respective registration.

Hazardous waste must be segregated according to classes stipulated in Appendices III and IV of the regulations. The regulations also require generators to identify their

55 The Decree 13/2006 of 15th June is published in Boletim da República No. 24, 1st Series, Supplement of 15 June 2006

56 cf. WMR, article 9.

corporate staff members responsible for the management of hazardous waste. The regulations further contain requirements for the collection, storage, packaging, transport, treatment and disposal and reporting of hazardous waste.

Hazardous waste should be separated (refer to Annex III), and each of its producing or handling entities should at least dispose of technical conditions for packing its waste.

Hazardous waste should be packed or wrapped according to technical standards and should at least be kept in containers with capacity to:

a) Endure normal storage and transport operations;

b) Stay hermetically sealed so that its content does not unintentionally go out;

c) Avoid damage by its content;

d) Avoid forming harmful or hazardous substances when in contact with its content;

e) Be properly identified by the symbols presented in Annex V, below.

The producing entities bear the exclusive responsibility for the collection of hazardous waste, and to this end should carry out in their own capacity the operations referred to in Annex VI, below, and assign its execution to a private or public collection service, duly licensed for the exercise of this activity.

In the act of collection a manifest should be filled in (refer to Annex VII), in quadruplicate, describing the quantities, quality and destination of the collected waste; one copy will be kept by the waste producing entity, another copy by the waste transporting entity, the third copy by the receiver of the product and the last copy will be sent to the Ministry for the Coordination of Environmental Affairs.

Inside the installations of the producing entity hazardous waste should be transported with the use of adequate equipment or vehicles (which should be properly washed and disinfected), with a solid base and walls capable of containing it from its point of origin until the packing, storage and treatment sites.

Outside the installations of the producing entity, the transportation of waste over public roads will be done with the necessary adaptations, in compliance with the provisions laid down in the Road Transport Code regarding the transit of vehicles transporting special cargo, which can only be transported by hauliers certified for this purpose by MICOA.

The entities involved in the disposal and elimination of hazardous waste should certify, through a risk assessment process carried out during the preparation of the waste management plan, the environmental viability to be adopted for the specific case (refer to Annex VI), with priority for the most advisable disposal option from a technical-scientific point of view.

Other regulations that should be taken into account regarding environmental issues include the Regulations for the Management of Ozone Depleting Substances and Resolution Nr. 78/2009 that banned the importation, exportation, production and commercialization of Ozone layer Depleting Substances.

The Regulations for the Management of Ozone Depleting Substances was approved by Decree nr 24/2008 from the 1st of July57.

The regulations have the objective to establish rules regarding the importation, exportation, transit and destruction of ozone depleting substances and equipments containing these substances aiming to prevent or minimize their negative impacts on the environment.

The following are covered by the Regulations:
a) The substances included in Annex 1 of the present Regulations, designated as controlled substances, either isolated or in a mix;
b) Aerosol packaging, acclimatization, refrigeration equipments that contain any of the substances referred in the previous paragraph.
The Regulations are not applied to the importation or exportation of the following:
a) Controlled substances destined for therapeutic or scientific purposes;
b) Personal use products or equipment part of the luggage of an individual residing in Mozambique or in transit in the country.
The Regulations state that the installation, maintenance and collection of portable fire extinguishers in buildings, installations, establishments or transport means will be regulated by specific regulations.

Resolution Nr. 78/2009 from the 22th of December58 banned the importation, exportation, production, commercialization, and transit of ozone depleting substances.

Thus, the following substances were banned:

i) chlorofluorocarbons (CFC);

j) Halogens (Halon – 1211, Halon – 1301 and Halon – 2402);

k) Carbon tetrachloride (CCL4);

l) Other substances defined according to the terms of the Montreal Protocol on Substances that Deplete the Ozone Layer ratified by Resolution nr. 8/93 from the 8th of December

57 Decree Nr. 24/2008 of the 1st of July is published in the Government Gazette Boletim da República No. 26, 1st Series, 3rd Supplement of the 1st of July 2008

58 Resolution No. 78/2009 of 22nd December is published in the Government Gazette Boletim da República No. 50, 1st Series, 3rd Supplement of the 22nd of December 2009

Protection and Conservation Areas & Biodiversity

The Land Law, approved by Law No. 19/97, of 1st October59, classifies land in the public domain as total and partial protection zones. As per Article 7 of said statute, total protection zones are designated as those reserved for nature conservation, defence and national security activities. Article 4 of the Land Law Regulations, approved by Decree No. 66/98, of 8 December60, sets forth that the legal framework applicable to total protection zones shall be defined in separate regulations. Pursuant to Article 8 of the Land Law, partial protection areas include, inter alia, the territorial seas, the EEZ, the continental platform as well as the coastline, islands, bays and estuaries up to 100 metres inland of the maximum high tide mark (Article 8).

In accordance with Article 9 of the Land Law, the use of land in total and partial protection zones requires the issuance of specific licenses for such purpose. Furthermore, the approval by the relevant authorities of public infra-structure construction projects, such as the installation of petroleum and gas pipelines, entails the automatic creation of a partial protection zone of 50 meters beyond the relevant area (Article 6.1 (d) of the Land Law Regulations).

Article 10 of the Forestry and Wildlife Law, approved by Law No. 10/99, of 7 July61, defines protection zones as being areas within the national boundaries, representative of the national natural heritage, designated for biodiversity conservation, with fragile ecosystems, or designated for the conservation of animal and plant species.

Pursuant to Article 11 of the Forestry and Wildlife Law, National Parks comprise total protection areas reserved for natural ecosystem preservation, development and conservation, as well as for the protection of sites of scientific, cultural or esthetical value and representative of the national heritage. Unless for scientific reasons, or as management requirements, the carrying out of following activities within National Park boundaries is prohibited:

- Hunting within the limits of Park boundaries
- Forestry exploitation, agriculture, mining or livestock rearing
- Surveying or prospecting for minerals, drilling or building of landfills
- All developments likely to alter the aspect of the area, or the characteristics of the vegetation as well as causing water pollution and generally all activities likely to cause disturbances of flora and fauna

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59 The Land Law, the Law No. 19/97 of 1st October, is published in Boletim da República No. 40, 1st Series, 3rd Supplement of 7 October 1997

60 The Decree No. 66/98 of 8th December is published in Boletim da República No. 48, 1st Series of 8th December 1998. These Regulations were altered by Decree 1/2003 of 18th February, published in Boletim da República No. 7, 1st Series, 2nd Supplement of 18 February 2003, and by Decree 50/2007 of 16th October published in Boletim da República No. 41, 8th Supplement of 16 October 2007

61 The Law No. 10/99 of 7th July is published in Boletim da República No. 27, 1st Series, 2nd Supplement, of 6 June 2002

- The introduction of indigenous, imported, wild or domestic zoological or botanical species

Exploration areas of Blocks Sofala and M-10 are located at between 50 – 100km to the Bazaruto Archipelago National Park.

Bazaruto National Park was created in 1971 by way of a pre-independence statute (Legal Diploma No. 47/71, of 25 May) in recognition of the environmental importance of the area by the Portuguese authorities, with the aim of protecting species of high ecological value, namely dugongs, dolphins, and sea turtles. At the time, the Park consisted of three islands, namely Benguerra, Magaruque and Bangué. The islands of Bazaruto and Santa Carolina were defined simply as areas for "special monitoring activities".

Decree No. 39/2001, 27 November62, changed the name of the natural park to its current designation and adjusted the boundaries of the National Park in order to include all the islands that are ecologically, socially and economically interrelated, as well as with the aim of promoting their integrated management.

With regard to protected species, the Forestry and Wildlife Regulations, approved by Decree No. 12/2002 of 6 June63, includes a list of protected fauna species that are illegal to hunt including dugongs, certain species of coastal/marine avifauna and marine turtles.

Table 6 List of Protected Species in Annex II of Forestry and Wildlife Regulations (64)

Name	Scientific Name
Mammals	
Dugong	*Dugong dugon*
Avifauna	
Flamingos	All species
Seagulls	All species
Herons	All species
Marabou Storks	*Leptoptilos crumeniferus*
Pelicans	All Species
Reptiles	
Sea Turtles	All Species

62 The Decree No. 39/2001 of 27th November is published in Boletim da República No. 48, 1st Series, Supplement of 27 November 2001

63 The Decree No. 12/2002 of 6th June is published in Boletim da República No. 22, 1st Series, 2nd Supplement of 6 June 2002

64 The list of protected species contained in Annex II of the Forest and Wildlife Regulations includes other species which are not mentioned herein. Should you wish us to provide you with a list, please let us know.

The Recreational and Sport Fishing Regulations, approved by Decree No. 51/99, of 31 August65, also includes a list of protected marine species, including marine mammals (dugongs, whales and dolphins), marine turtles, and some species of fish, bivalves and gastropods.

Table7 List of protected species included in Annex II of Decree No. 51/99

Common Name	Scientific Name
Fishes	
Brindle bass	*Ephinephelus lanceolatus*
Seventy-four	*Polysteganus undulosus*
Potato bass	*Ephinephelus tukula*
Red steenbras	*Petrus rupestris*
White shark	
Reptiles	
Marine turtles	*All species*
Mammals	
Dugong	*Dugong dugon*
Whales	*All species*
Dolphins	*All species*
Bivalves	
Giant clam	*Tridacna gigante*
Scaled clam	*Tridacna squamosa*
Gastropods	
Horned helmet	*Cassis cornuta*
Trumpet triton	*Charonia Tritonis*

Cultural Heritage

The Cultural Heritage Protection Law, approved by Law No. 10/88, of 22 December66, legally protects the "material and non-material goods, created or integrated by the people of Mozambique along the course of their history, with relevance for the definition of Mozambican cultural identity."

The cultural goods include monuments, buildings with historical importance, artistic and scientific places or sites (with archaeological, historic, aesthetic, technologic or anthropologic value), and natural elements (physical and biological formations, with particular scientific and aesthetic interest. The Bazaruto Archipelago is specified in this Law as an example of a natural site of aesthetic and scientific interest.

Article 13 of this Law specifies that in the case of a discovery of any site, building, object or document likely to be classified as cultural heritage, the administrative authorities must be notified within 48 hours (Article 10).

The Decree No. 27/94 of the 20th of July approved the Regulations for the Protection of the Archaeological Heritage67.

65 The Decree No. 51/99 of 31st August is published in Boletim da República No. 34, 4th Supplement of 31 August 1999

66 The Law No. 10/88 of 22 December is published in Boletim da República No. 51, 1st Series, 3rd Supplement of 22 December 1988

67 The Decree No. 27/94 de 20th July is published in Boletim da República No. 29, 1st Series, Supplement f 20 July 1994

The Forestry and Wildlife Law also defines Areas of Historic-Cultural Use and Value as protected areas, with the objective of protecting sites with historic importance or sites with cultural use value to local communities.

B1.4 INSTITUTIONAL FRAMEWORK

B1.4.1 Ministry for the Coordination of Environmental Affairs

The Ministry for the Coordination of Environmental Affairs (MICOA) is responsible for coordinating all environmental activities at national level in order to promote the management, preservation and rational use of the country's natural resources as well to propose environmental policies and strategies for integration in sectoral development plans. The Ministry is to promote the sustainable development of the country through the steering of the implementation of the country's environmental policy.68

In order to execute its objectives and duties, this ministry is structured in the following areas of activity:69

a) Inter-sectoral Coordination;
b) Research, Environmental Planning and Management;
c) Land Planning and Organization;
d) Environmental Impact Assessment;
e) Environmental Promotion, Education and Dissemination;
f) Inspection and Supervision.

In order to implement the above mentioned activities, the Ministry for the Coordination of Environmental Affairs presents the following structure:

a) General Inspection;
b) National Directorate of Environmental Management;
c) National Directorate of Land Planning and Organization;
d) National Directorate of Environmental Impact Assessment;
e) National Directorate for Environmental Promotion;
f) National Directorate for Planning and Studies;
g) Directorate of Human Resources;
h) Directorate of Administration and Finances;
i) Department of ~~International~~ Cooperation
j) Legal Office;

68 See Presidential Decree No. 6/95 of 10th November published in the Boletim da República No. 48, 1st Series, Supplement, of 29th November 1995
69 See Resolution No. 16/2009 of 5th August published in Boletim da República No. 31, 1st Series of 5 August 2009 and Ministerial Diploma No. 265/2009 of 16th December published in Boletim da República No. 50, 1st Series of 16 December 2009.

k) Minister's Office.

The Ministry for the Coordination of Environmental Affairs has as it subordinate institutions:

a) Centre for Sustainable Development for Coastal Areas (CDS-ZONAS COSTEIRAS);
b) Centre for Sustainable Development of Urban Areas (CDS-ZONAS URBANAS);
c) Centre for Sustainable Development of Natural Resources (CDS-RECURSOS NATURAIS
d) Centre for Research of Marine and Coastal Environment (CEPAM)
e) Medium Level Institute of Land Use Planning and Environment (Instituto Médio de Planeamento Físico e Ambiente) (IMPFA)

The relevant directorates for Environmental Impact Assessment studies are:

1. National Directorate of Environmental Management
2. National Directorate for Environmental Impact Assessment.

The duties of the National Directorate for Environmental Management are:

a) To propose policies, plans and standards for the correct use of the environmental components and environment control quality;
b) To promote global and integrated air, water, soils and other environmental components quality program;
c) To propose the establishment of environmental quality standards and to promote its implementation;
d) To participate in the definition of sustainable development indicators;
e) To promote environmental conservation actions, aiming in particular, to preserve biodiversity, sustainable management of sensitive or protection areas and the rehabilitation of degraded areas;
f) To promote the integrated and sustainable management of urban and coastal areas.

The duties of the National Directorate for Environmental Impact Assessment are:

a) To propose legislation to guide the implementation of environmental management of potential degrading activities;
b) To conduct environmental licensing of potentially degrading activities for the environment;

c) To conceive and implement pilot-projects for the evaluation of cumulative environmental impacts in the main economic development areas;
d) To manage and coordinate the environmental impact assessment process;
e) To prepare and issue general and specific guidelines on the environmental impact assessment process;
f) To act, in collaboration with public and private entities interested and

the civil society for the analysis of environmental studies in the scope of the environmental impact assessment;

g) To promote the monitoring of environmental impacts and environmental audits to ventures that can cause harm to the environment;

h) To approve the specific terms of reference presented by the proponents of the development activities that will serve to guide the environmental impact studies;

i) To register and keep a record of professionals and consulting companies qualified to conduct environmental impact studies and environmental audits;

It is important to note that the National Directorate for Environmental Impact Assessment, apart from managing and coordinating the Environmental Impact Assessment process, is also responsible for monitoring the environmental impacts as well as environmental audits.

B1.4.2 National Petroleum Institute

The National Petroleum Institute (INP) is the regulatory body for hydrocarbon research, production and transportation activities70.

The National Petroleum Institute is a legal entity governed by public law, with administrative, financial and patrimonial autonomy that performs its competences based on technical capacity and impartiality.

The INP is based in Maputo, with delegations in the provinces.

In the scope of the research activity, the INP has the following competences:

a) To evaluate and update the knowledge of petroleum potential in the national territory;

b) To develop actions to promote investment in petroleum surveying;

c) To participate in the definition of the contract, minimum work obligations of the title holders of the contracts and concessions.

Without judgment of other powers awarded by law and other applicable standards, the INP, in the scope of its competences and attributions, must inspect the locations, buildings and facilities where petroleum operations are conducted and must also observe the execution of petroleum operations and inspect all assets, registry and data in the possession of the operator.

The INP has as main bodies:

70The National Petroleum Institute was created by Decree No. 25/2004 of 20th August, published in the Boletim da República No. 33, 1st Series, of 20th August 2004

a) The Board of Directors
b) The Supervisory Board
c) The Governing Board

The Board of Directors will create support and technical consultation bodies or any others, permanent or temporary, needed for the operation of the INP. The mandates of the members of the Board of Directors, including the Chairman are 5 (five) years, renewable.

It is based on these statutes that the INP is responsible for the supervision and monitoring of all aspects of seismic exploration and must ensure that the proponent complies with the proposed Environmental Management Plan (EMP).

B1.4.3 National Maritime Institute (INAMAR)

INAMAR – National Maritime Institute is the institution commonly known and designated by Maritime Authority.

INAMAR, is a legally constituted public institution with administrative and financial autonomy created by the Government of the Republic of Mozambique through Decree No. 32/2004 of 18th August[71], as the "Regulatory Maritime Authority" (Article 1 of Decree No. 32/2004), in accordance to Article 30 of the Law of the Sea, the Law No. 4/96 of 4th January in its Chapter VII on Maritime Administration.

INAMAR's aim is to act in the fields of maritime safety, protection of ships and port facilities, maritime transportation, agency and stowing, maritime personnel, preservation of marine environment and maritime administration (Article 3 of Decree No. 32/2004 of 18th August).

The competences of INAMAR include, inter alia, the following:

- To apply and ensure the compliance of national legislation on maritime safety and international conventions on maritime issues the country has ratified;
- To license, supervise and control the Navy's activities;
- To supervise compliance with legislation, regulations and safety procedures in maritime infra-structures and to support maritime navigation;
- To certify, supervise and license maritime equipment and material;
- To inspect and license the exploration of port infra-structures and to support maritime navigation and related activities;
- To license, provide credentials and acknowledge the classified partnerships of ships and maritime material;

71 The Decree 32/2004 of 18th August is published in the Boletim da República No. 33, 1st Series, of 18th August 2004

- To instruct and make decisions on licensing processes for transportation activities and maritime works;
- To promote actions to prevent and fight against maritime pollution;
- To act on and penalize the offenders of legislation and relevant procedures for the safety of maritime navigation, maritime industry and related activities;
- To participate, in coordination with other relevant authorities, in search and rescue activities; and
- To collect taxes and fees due for services rendered.

In the context of hydrocarbon research activities, special attention must be given to paragraphs 2 (Maritime safety), 4 (Maritime transportation, agency and stowing), 6 (Preservation of the marine environment) and 7 (Maritime administration) of Article 3 of the Organic Statute, regarding the specific competences of INAMAR that detail the mandate of INAMAR as a Maritime Authority.

The specific competences of INAMAR are the following:

Article 3 - Paragraph 2: With regards to maritime safety:

- To control vessels and registered national maritime, wherever they are, and foreign vessels in national territorial waters;
- To apply and enforce safety standards on national and foreign vessels related to maritime trade, fishing, recreation and on any other floating constructions;
- To lead the supervision, inspection and certification processes for national and foreign vessels related to maritime trade, fishing, recreation and any other floating constructions;
- To lead the validity processes for vessel certificates granted by foreign maritime authorities;
- To ensure communications between vessels and national coastal stations, aiming to safeguard human life and goods at sea;
- To control the handling and transportation of dangerous goods, in coordination with other competent authorities; and
- To conduct investigations on accidents, incidents and processes related to maritime offenses and submit them to the relevant authorities.

Article 3 - Paragraph 4. With regards to maritime transportation, agencies and stowing:

- To license, authorize and supervise commercial maritime transportation activities, ship managers, private maritime transportation, maritime tourism transportation and recreational navigation;
- To license and supervise agency activities and complementary services;
- To license and supervise diving activities;
- To license and supervise towing and maritime rescue activities; and
- To license and supervise related maritime activities.

Article 3 – Paragraph 6. With regards to the preservation of the marine environment:

- To propose legislation and regulations to prevent, reduce, control and combat pollution of the marine environment by vessels, floating or fixed at sea, taking international conventions into consideration;
- To lead and coordinate actions for prevention and fight against marine pollution, with the participation of other relevant national and international entities;
- To participate or join organizations and international forums aimed at the establishment of rules and standards, as well as international and regional practices and procedures to prevent, reduce, control and fight against the pollution of marine environment by ships; and
- To take other measures necessary to prevent, reduce and control marine pollution.

Article 3 – Paragraph 7. With regards to maritime administration:

- To register vessels, issue related documentation, establish and maintain records updated;
- To sanction employment contracts between crews and ship owner's or their representatives;
- To define the minimum safe manning for vessels under national flag and issue corresponding certificates;
- To issue opinions on activities to be carried out in public maritime domains, rivers and lakes;
- To authorize or determine the opening or closing of ports and port terminals;
- To hold or participate in inquiries on accidents and maritime incidents; and
- To supervise maritime activities committed to it (the institute) by law.

B1.4.4 National Hydrography and Navigation Institute (INAHINA)

The National Hydrography and Navigation Institute (INAHINA) was created by Decree No. 27/2004 of 20th August[72].

INAHINA has the following competences:

- Responsible for safety of maritime navigation, through emission and dissemination of "Notice to Mariners" for maritime navigation in the waters under the jurisdiction of the Republic of Mozambique (Line (d) of Article 5 of the Organic Statute of INAHINA integrated in Decree No. 27/2004 of 20th August)[73];

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72 The Decree No. 27/2004 of 20th August is published in Boletim da República No. 33, 1st Series, 2nd Supplement of 20th August 2004

73 *Aviso aos Navegantes* is an Information Newsletter on any changes to safety in navigation in waters under national jurisdiction.

- Responsible for preparation and sale of nautical publications such as charts, navigation routes, lists of lighthouses, tide tables, among others;

- Responsible for the operation and maintenance of Navigation Aids (Lighthouses, Beacons, Buoys, and other signals) in the waters under the jurisdiction of the Republic of Mozambique.

B1.5 SASOL'S SAFETY, HEALTH AND ENVIRONMENTAL POLICY

Sasol's Safety, Health and Environmental (SHE) Policy establishes the framework for the management of the organization's activities, including the exploration activities envisaged in Blocks Sofala and M-10. This policy is provided overleaf:

Safety, Health and Environmental Policy

We, the people of Sasol, striving for excellence in all we do, recognize the impact that our activities can have on people and the environment. Safety, health and protection of the environment will form an integral part of our planning and decision-making. We will manage our company, wherever we do business, in an ethical way that strikes an appropriate and well-reasoned balance between economic, social and environment needs.

We are committed to:

- Conducting our business with respect and care for people and environment
- Responsible utilization of natural resources
- Implementing responsible care for all Sasol's chemical and associated businesses. Non-chemical businesses will implement appropriate, recognized codes of practice
- Continually improving our safety, health and environment performance
- Complying, as minimum, with all applicable legal and other agreed requirements
- Promoting dialogue with stakeholders about safety, health and environmental performance

We will achieve these by:

- Implementing internationally recognized safety, health, environmental and quality management systems
- Developing and implementing inherently safer and cleaner technologies
- A "cradle to grave" approach to the to the products we develop, manufacture, use, distribute and sell
- Informing and appropriately training all employees and contractors on safety, health and environmental matters
- Responding effectively to safety, health and environmental emergencies

involving our operations and products

- Engaging with relevant authorities and institutions on the formulation of legislation, standards and the implementation thereof
- Benchmarking internationally on best safety, health and environmental practices
- Sharing safety, health and environmental risk reduction best practices throughout Sasol
- Providing appropriate resources required to implement the above

Pat Davies
Chief Executive

B1.6 INTERNATIONAL GUIDELINES

B1.6.1 International Association of Drilling Contractors (IADC)

This guide is designed to supplement company Health, Safety and Environmental programs and operating procedures. It is based on experience and careful study over many years. Practicability has been substantiated by the adoption of the safe operating procedures by many drilling contractors and government regulatory bodies. It gives the drilling contractor a basis on which to build a Health, Safety and Environmental program.

Of particular interest for the present project are chapters 12, related to Offshore Safety, covering aspects such as medical evacuation to rough weather procedures; and chapter 14, related to the Protection of the Environment covering air emissions, waste management, spill prevention and control amongst others.

The guidelines also cover aspects related to Fire Prevention and Control, Personal Protective Equipment and Emergency Action Plan(s). These aspects are also addressed in the Mozambican Regulations for Petroleum Operations.

B1.6.2 International Association for Oil and Gas Producers (OGP)

The OGP have been producing many documents and guidelines over the past few years to help its members to develop best practices in Health, Safety and Environment. Of special importance for the project are:

- Environmental Aspects of the use and disposal of non aqueous drilling fluids associated with offshore oil and gas operations – it provides a comprehensive synopsis of what is known around the world about the environmental impacts of this discharge;

- Environmental management in oil and gas exploration and production – It provides an overview of the environmental issues and the technical and management approaches to achieving high environmental performance in the activities necessary for oil and gas exploration and production around the world;

- Guidelines for the development and application of Health, Safety and Environmental Management Systems – it describes the main elements necessary to develop, implement and maintain a Health, Safety and Environmental Management System by the operators;

- Exploration and Production (E&P) Waste Management Guidelines – it provides a general description of waste management principles; an identification and overview of E&P activities and associated wastes; and options of waste reduction, recycling, treatment and responsible disposal; and

- Key questions in managing social issues in Oil & Gas Projects – it provides a tool to help with social planning issues and are targeted to: project management, by helping to identify questions that may be important in their leadership role; and business and project teams, by helping in the identification of questions that may be important in project development and management.

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FINAL Report + Addendum

Drilling Discharges and Oil Spill Modeling, Blocks SOFALA & M-10, offshore Mozambique

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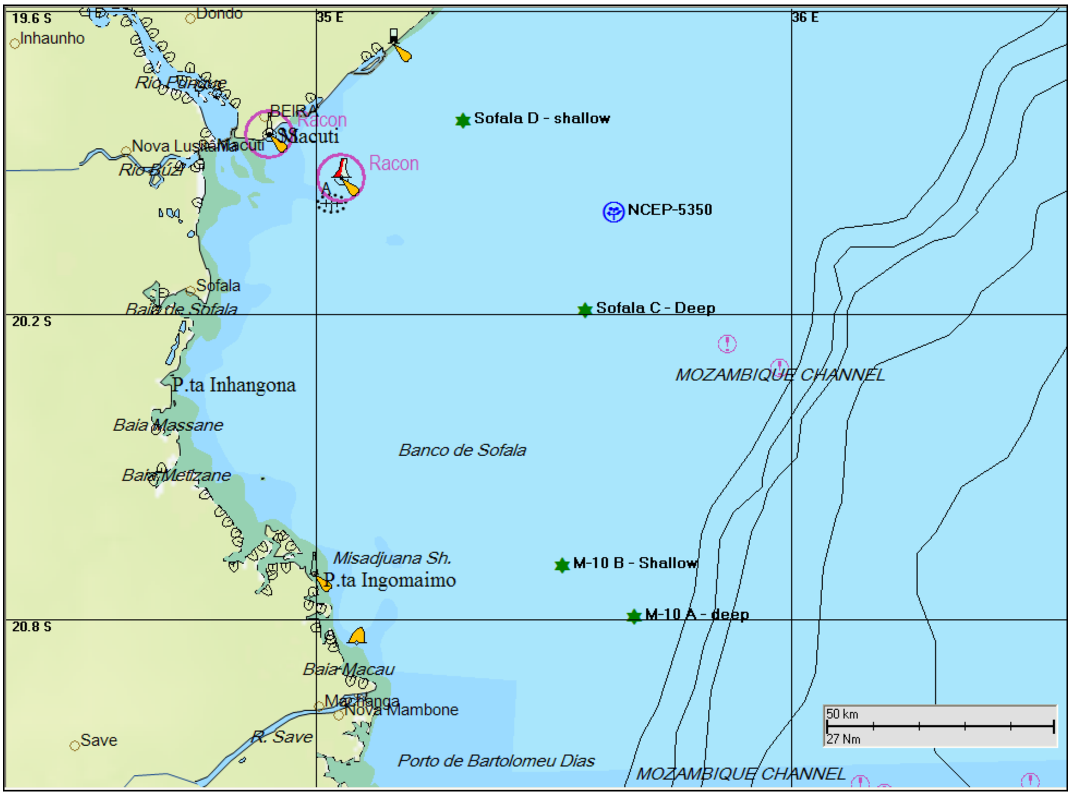
ERM Southern Africa



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List of Acronyms

API	American Petroleum Institute
ASA	Applied Science Associates
B-BO	Location Bravo - Blowout
B-HFO	Location Bravo – small HFO spill
CDC	Climate Diagnostics Center
D-BO	Location Delta - Blowout
D-HFO	Location Delta – small HFO spill
ERM	Environmental Resources Management
HFO	Heavy Fuel Oil
MUDMAP	A personal computer-based model developed by ASA to predict the near and far field transport, dispersion, and bottom deposition of drill muds and cuttings and produced water.
NCEP	National Center for Environmental Predictions
NOAA-CIRES	National Oceanic and Atmospheric Administration - Cooperative Institute for Research in Environmental Studies
OILMAP	A personal computer based oil spill response system applicable to oil spill contingency planning and real time response.

Executive Summary

ERM Southern Africa contracted with Applied Science Associates (ASA) to evaluate the extent of potential oil spills and drilling related discharges from blocks M-10 and Sofala off the coast of Mozambique. Simulations of spills of condensate and heavy fuel oil were completed using ASA's OILMAP oil spill modeling system. Model output includes the identification of sea surface and shoreline areas that could potentially be oiled and the associated probability of oiling, as well as the time required for oil to reach any of the predicted impact areas. The oil spill model also predicts a time history of oil weathering over the duration of the simulation, accounting for oil on the water surface, on the shore, evaporated, and entrained in the water column.

Simulations of drilling mud and drill cuttings discharges were done using the MUDMAP model system. The MUDMAP model predicts the seabed deposition of materials discharged during the drilling.

A basic climatological analysis was performed to determine the wind and current forcing in the area and these datasets were used as inputs to the models. Currents in the area of the wells are driven by shore-perpendicular tides and by the predominantly southward flowing Mozambique current. Large scale anti-cyclonic eddies move from north-to-south through the region several times a year and superimpose counter-clockwise flow patterns.

Drill Cuttings and Mud Discharge Simulations

Discharges from the Sofala-Charlie well, which is close to the shoreline, are driven primarily by tidal currents and the resulting seabed deposits exhibit a shore-perpendicular orientation. Discharges from the M10-Alpha well, which is closer to the shelf break, are driven by a combination of tides and the larger scale Mozambique currents flowing southward. Sediment deposits trend towards the south, following the predominant southern flow, but with a small cross-shore component due to the tidal currents.

Oil Spill Surface Simulations

Because of the proximity of the wells to the coast, all spill scenarios lead to a high probability (> 85%) of some degree of shoreline impact.

Spills of condensate and heavy fuel oil have greater than 85% probability of impacting the shoreline. The percentage volume of condensate impacting the coast is small (5-15%) due to its higher evaporation rate. At the end of the simulation, there is no condensate left in the water or on the shoreline. Spills from the Delta well have a higher chance of coastal impact with shorter times to shore due to the proximity to the coast and the predominant SE winds that push the pollutant towards the coast. Shoreline oiling from the heavy fuel oil spills is predicted to exceed 200 tonnes and reach the shoreline within 1 to 2 days.

1. Introduction

ERM Southern Africa contracted with Applied Science Associates (ASA) to evaluate the extent of potential oil spills and drilling related discharges from blocks M-10 and Sofala off the coast of Mozambique (Figure1 shows the locations). Simulations of spills of condensate and heavy fuel oil were completed using ASA's OILMAP oil spill modeling system. OILMAP inputs include shoreline definition, area circulation features, long term wind time series, spill locations and oil properties. The OILPMAP stochastic model output includes sea surface and shoreline areas that could potentially be oiled and the associated probability of oiling, as well as the time required for oil to reach any of the predicted impact areas. The OILMAP deterministic trajectory/fate model output includes a time history of oil weathering over the duration of the simulation, expressed as the percentage of spilled oil on the water surface, on the shore, evaporated, and entrained in the water column.

Simulations of drilling mud and drill cuttings discharges were done using the MUDMAP model system. MUDMAP uses a specification of the discharged fluids and solids and a spatial- and time-varying definition of ocean currents to predict the resulting water column concentration and seabed deposition.

Input data for the models, including the study location, is described in Section 2. Section 3 contains the characterization of drill cuttings and mud simulations and the modeling results. The model inputs and results of the oil spill model simulations are described in Section 4. Conclusions are given in Section 5. A description of the MUDMAP model system can be found in Appendix A. Appendix B provides an overview of the OILMAP system.

In September 2010, ASA was requested to simulate two additional drilling discharge scenarios, using a different combination of drilling fluids and an adjusted volume of total bulk material discharged. Results are presented in Appendix C.

2. Model Setup and Environmental Data

2.1. Study Location

The two offshore blocks of interest in this study are located in the central part of Mozambique, in the vicinity of the Pungue River; Block Sofala is approximately 70 km east of the city of Beira, and M-10 is situated 85 km farther south. Table 1 lists the coordinates of four wells to be studied. Both blocks are in fairly shallow water (less than 100m).

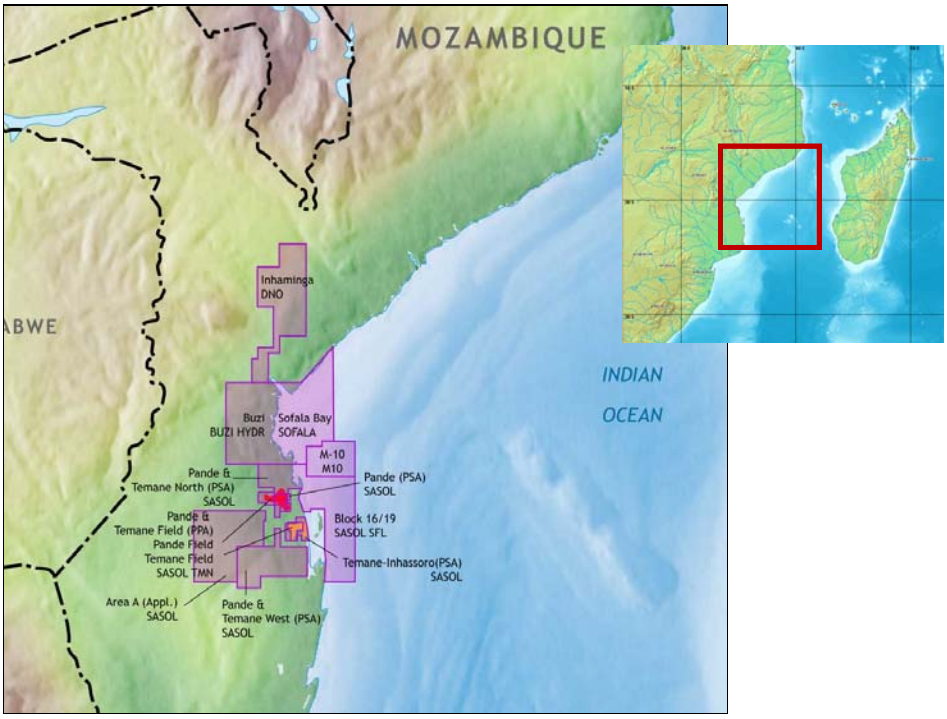

Figure 1. Location of offshore Blocks M-10 and Sofala.

Table 1. Coordinates of the well locations of interest in the offshore Blocks M-10 and Sofala.

Block		Latitude (N)	Longitude (E)	Approx. Water Depth	Drilling Program
M-10	Alpha	20° 47' 43.27" S	35° 40' 12.96" E	100m	Deep
	Bravo	20° 41' 40.95" S	35° 31' 08.77" E	50m	Shallow
Sofala	Charlie	20° 11' 37.57" S	35° 34' 02.56" E	30m	Deep
	Delta	19° 49' 08.22" S	35° 18' 33.80" E	20m	Shallow

Applied Science Associates

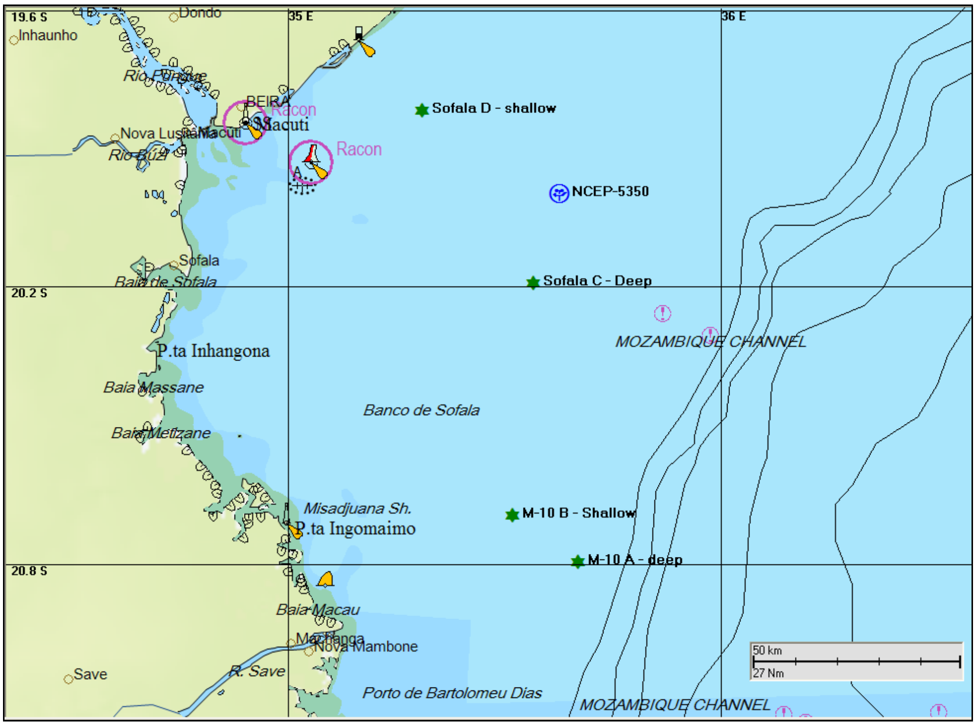

Figure 2. Location of the 4 well sites located in the offshore Blocks Sofala (Delta and Charlie) and M-10 (Alpha and Bravo).

2.2. Wind Data

Oil spill models use wind as one of the primary forces moving oil on the sea surface. Optimally, a minimum of ten years of observed wind data would be used as input to the model, although such data are not typically available and wind data must be obtained from the output of a numerical atmospheric model. The National Center for Environmental Predictions (NCEP) Environmental Modeling Center Regional Spectral Model maintained by the U.S. National Oceanic and Atmospheric Administration - Cooperative Institute for Research in Environmental Studies (NOAA-CIRES) Climate Diagnostics Center (CDC), provides global wind data. The NCEP datasets comprise long-term model wind time series and more accurately describe the wind characteristics than a statistical representation, such as a wind rose, when performing oil spill modeling.

For this study, wind speed and direction data from 6 NCEP model grid sites were obtained from the NOAA/CDC data server for the ten-year period from January 1, 1999 to December 31, 2010. Figure 3 shows the location of the NCEP grid points.

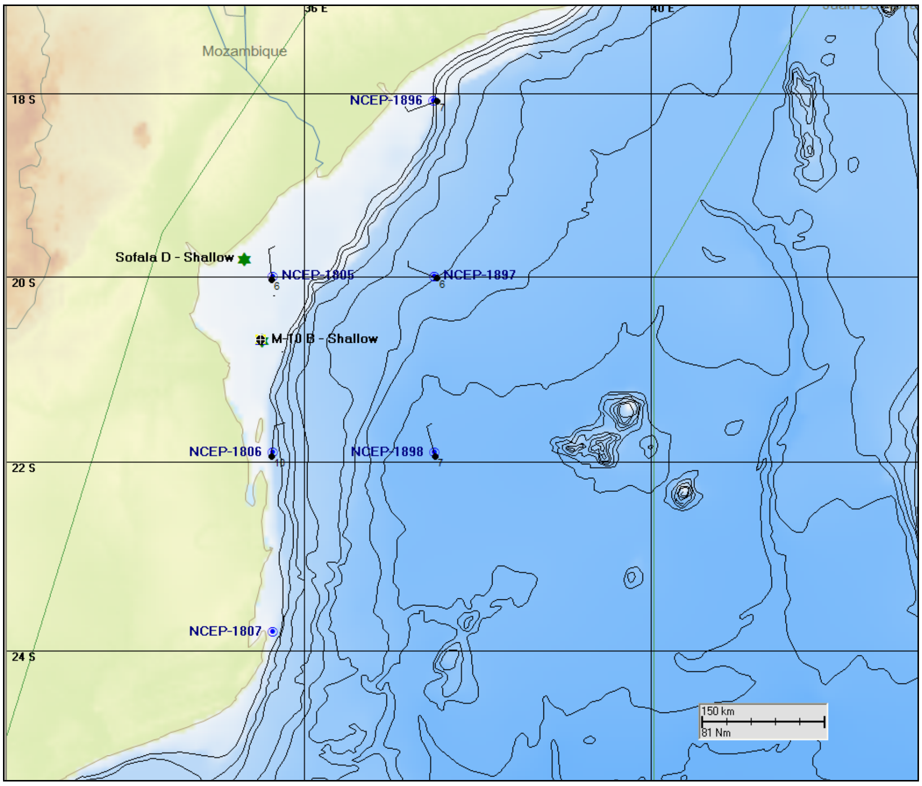

Figure 3. Location of the NCEP points were the wind dataset was gathered for the oil spill simulations.

Figures 4 and 5 contain monthly and annual wind roses from two NCEP grid points (#1805 and #1806) closest to block M10 and the Sofala block. Winds are variable year around with the predominant wind coming from the southeast quadrant.

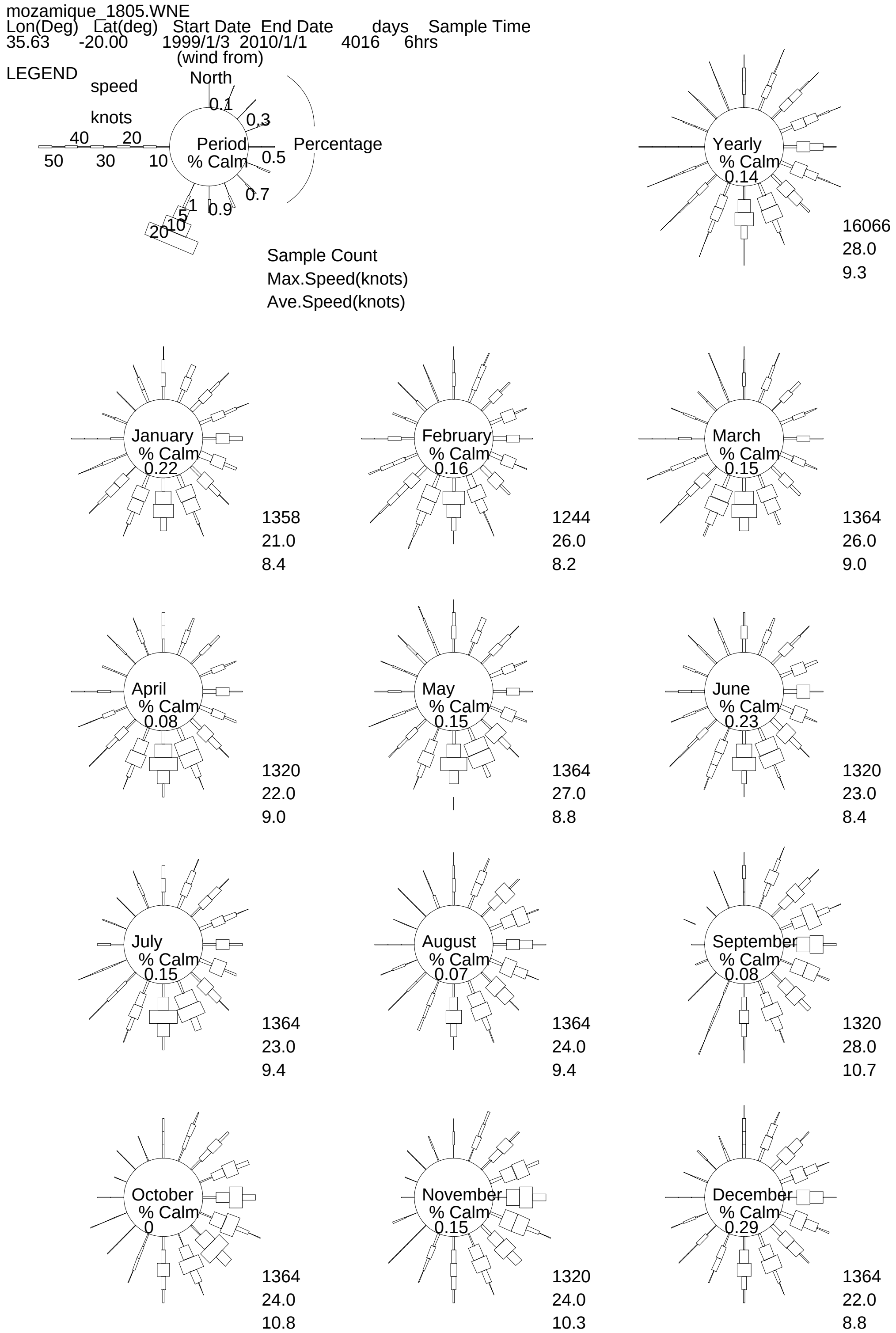

Figure 4. Monthly Wind Roses from the NCEP #1805 site.

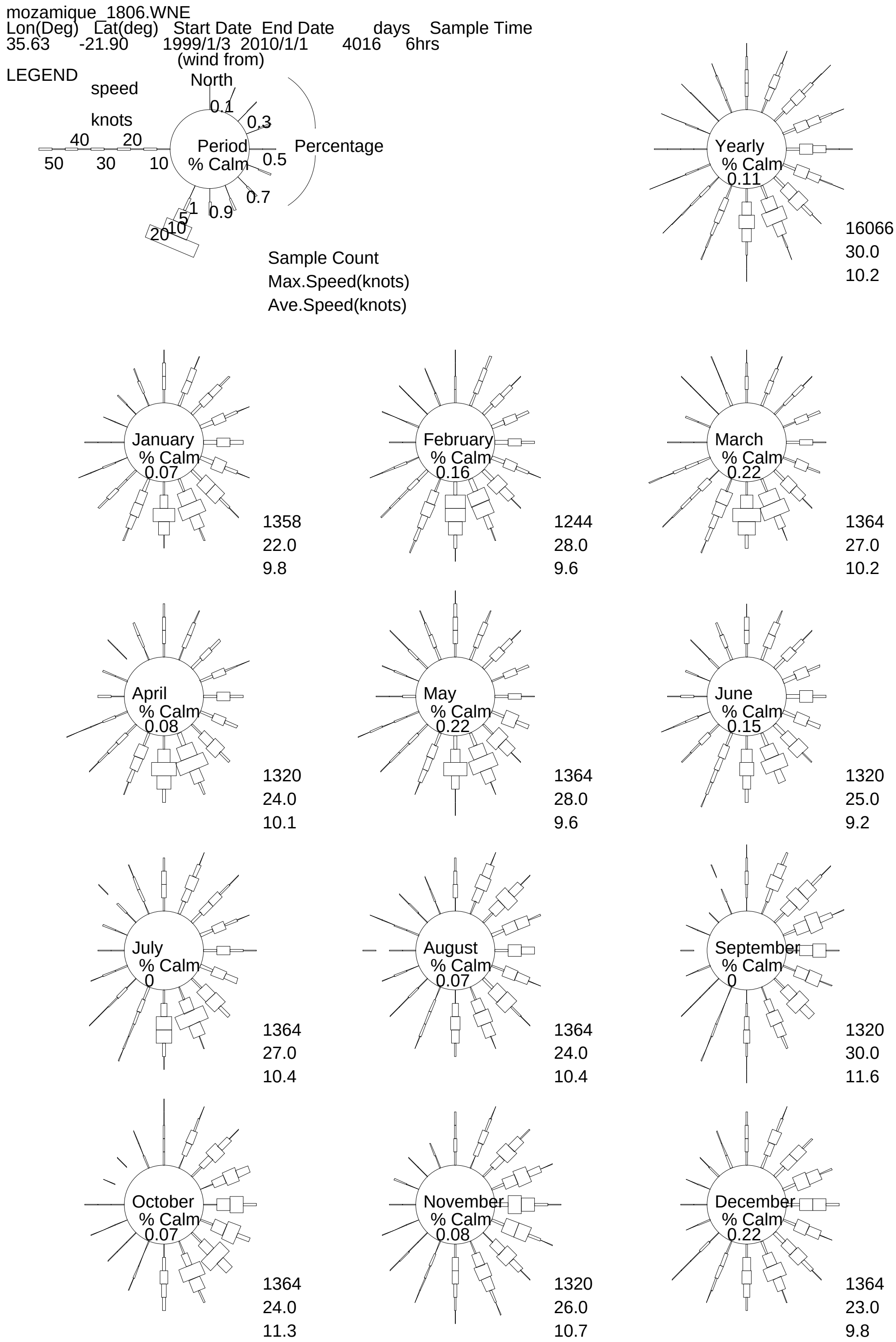

Figure 5. Monthly Wind Roses from the NCEP #1806 site.

2.3. Ocean and Coastal Circulation

All well sites are located in relatively shallow water (30m to 100m) on the Sofala Bank, the widest portion of shelf in the Mozambique Channel. Significant water movements on the Bank are driven by astronomical tides. The map of tidal ellipses shown in Figure 6 illustrates the shore-perpendicular nature of the tidal flow on the Bank.

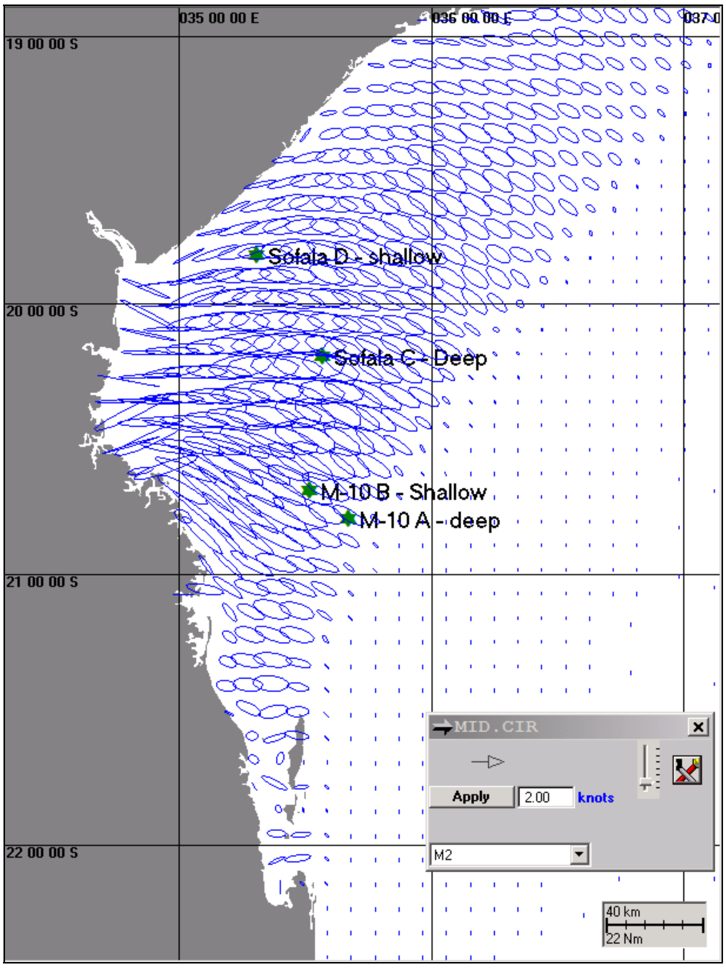

Figure 6. Tidal ellipses on the Sofala Bank.

In addition to tidal currents, the Mozambique current that flows southward along the shelf contributes sub-tidal circulation to varying degrees depending on the distance from the shelf break. Within the southward flows, intense anti-cyclonic (counter-clockwise) eddies that may be up to 350km in diameter and extend all the way to the sea floor, develop year-round. The paths taken by these eddies are often uniform, following the bathymetry. In any given year an average of four of these eddies pass southward through the Mozambique Channel, traveling 3 - 10 km/day (Schoutena et al, 1987).

Regional currents for the study area were obtained from a model hindcast analysis using inputs from the HYCOM (HYbrid Coordinate Ocean Model) 1/12 degree global simulation assimilated with NCODA (Navy Coupled Ocean Data Assimilation) provided by the US Naval Research Laboratory (http://www.hycom.org). This HYCOM dataset covers the period from 2003 to 2009. The model domain is resolved on a horizontal grid of 1/12 degree resolution in the horizontal direction, and variable vertical resolution depending on depth.

Figure 7 shows an average current field over the seven year period 2003 to 2010 depicting the effect of multiple passages of anti-cyclonic eddies. As rotating eddies move southward, water on the west side of the cyclone flows towards the south while flow on the east side will be towards the north. At the eddy center the current velocity is essentially zero. The thick blue line indicates the center of the path of a typical eddy.

Figure 8 shows a current field snapshot (daily value) from the HYCOM global hydrodynamic model depicting an example of an anti-cyclonic eddy. The center of the eddy can be seen approximately 125km west of Sofala Bank. Although none of the well sites will be in the path of these eddy systems, their presence will affect the transport and fate of oil floating on the sea surface.

While the dispersion of drilling discharges is controlled primarily by local vertically-variable currents, oil spills are transported by a combination of winds and surface currents. Because surface spills can cover large areas, they are subject to the spatial and temporal variability of winds and the large scale current features in the area of the wells. For the oil/condensate spill stochastic simulations, the entire 7-year current dataset was used to define the flow. This current data set captures the spatial and temporal variability of currents in the region, particularly the effect of the passing eddies. For the drilling discharge deterministic simulations, an average current field was defined which is appropriate for the smaller extent of the discharge plume.

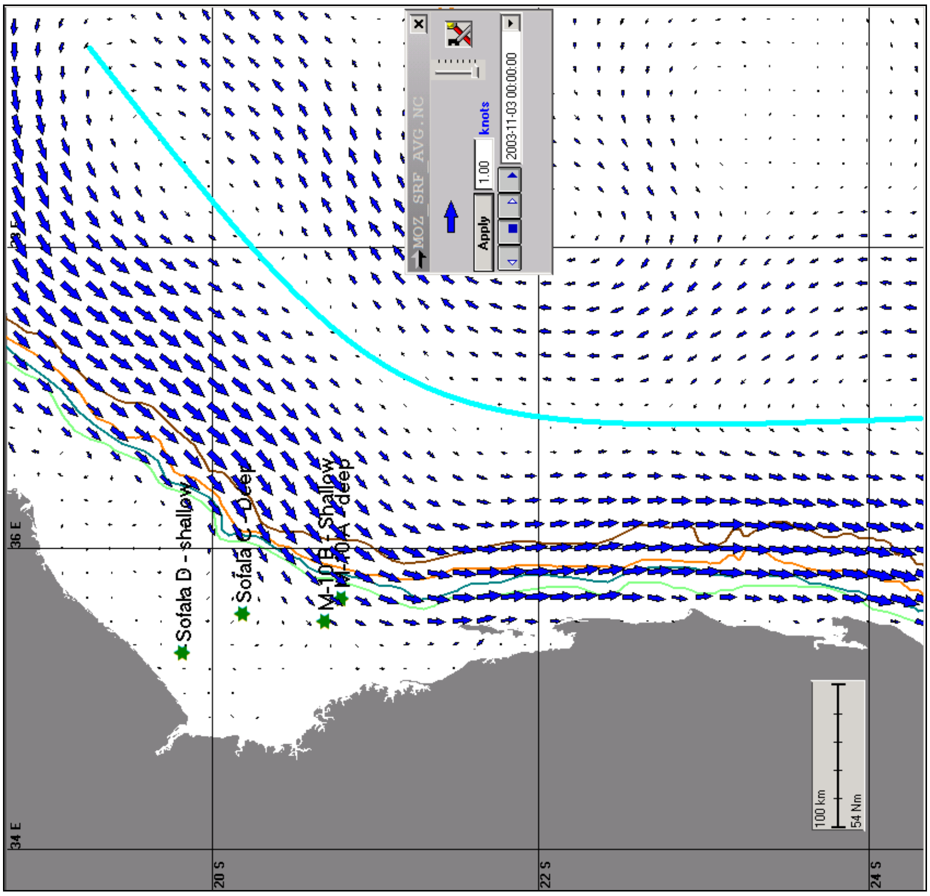

Figure 7. Average current field over a 7 year period. Blue line shows the center-line of typical eddy passage

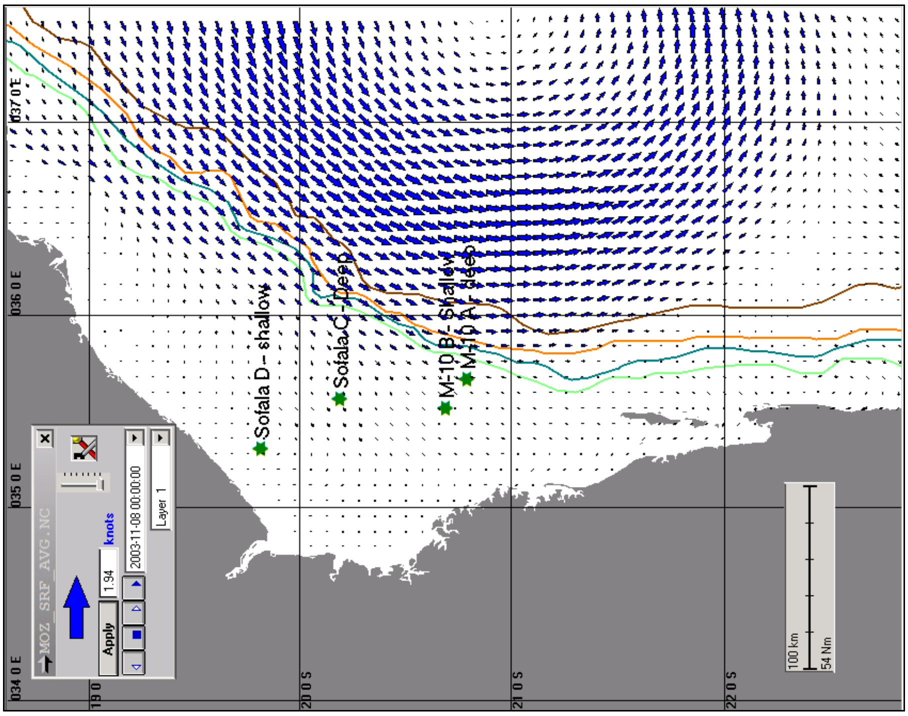

Figure 8. Current snapshot during eddy passage.

3. Drilling discharges simulations

3.1. Model description

ASA's MUDMAP was used to perform the mud and drill cuttings dispersion modelling. MUDMAP is a numerical model developed by ASA to predict the near and far field transport, dispersion, and bottom deposition of drill mud and cuttings. In MUDMAP, the equations governing conservation of mass, momentum, buoyancy, and solid particle flux are formulated using integral plume theory and then solved using a Runge Kutta numerical integration technique[1]. The model includes three stages: convective descent/ascent, dynamic collapse, and far field dispersion. It allows the transport and fate of the release to be modeled through all stages of its movement. The initial dilution and spreading of the plume release is predicted in the convective descent/ascent stage. The plume descends if the discharged material is denser than the local water at the point of release and ascends if the density is lower than that of the receiving water. In the dynamic collapse stage, the dilution and dispersion of the discharge is predicted when the release impacts the surface, bottom, or becomes trapped by vertical density gradients in the water column. The far field stage predicts the transport and fate of the discharge caused by the ambient current and turbulence fields.

The model's output consists of the accumulation of discharged solids on the seabed. The model predicts the initial fate of discharged solids, from the time of discharge to initial settling on the seabed. As MUDMAP does not account for resuspension and transport of previously discharged solids, it provides a conservative estimate of the potential seafloor deposition. The far field, passive diffusion stage uses a particle based random walk model. This is the same random walk model used in other ASA modeling systems. More details about MUDMAP are included in Appendix A.

3.2. Discharge Scenarios

The study consisted of simulating the discharge of bulk material from the proposed well locations (Table 2) during the expected drilling period (March-November). Discharge volumes are listed in Table 3 and the particle settling velocities for drill cuttings and mud are listed in Tables 4 and 5, respectively.

The drill cuttings grain size distribution used in this study were provided by the client, based on previous studies in the vicinity of the area of study.

In September 2010, ASA was requested to simulate two additional drilling discharge scenarios, using a different combination of drilling fluids and an adjusted volume of total bulk material discharged. Results are presented in Appendix C.

[1] In numerical analysis, the Runge–Kutta methods are an important family of implicit and explicit iterative methods for the approximation of solutions of ordinary differential equations.

Table 2. Location of the expected drilling well sites, Alpha and Charlie, offshore Mozambique

Name	Block	Longitude	Latitude	Depth
Alpha	M-10	35° 40' 13"	-20° 47' 43"	~100m
Charlie	Sofala	35° 34' 03"	-20° 11' 38"	~30m

Table 3. Expected Depths for the Drilling program discharges at Block M-10 and Sofala wells.

Sections	Diameter (in)	Depth(m)	Cutting Volume (m^3)	Mud Volume (m^3)	Discharge location
1	36	100	100	7.0	Seabed
2	26	300	70	4.9	Surface
3	17.5	750	70	4.9	Surface
4	12.25	3000	174	8.7	Surface
	TOTAL	4150 m	414 m^3	21.6 m^3	

Table 4. Drill cuttings fall velocity distribution (provided by Client)

Particle Size (microns)	Percent Volume	Settling Velocity (cm/s)
1	1	0.00004
2	0.5	0.00017
3	1.25	0.00038
4	1.25	0.00068
6	1.5	0.00152
8	2	0.00271
11	2	0.00511
16	2	0.01082
22	1.5	0.02046
31	1.5	0.04062
44	2	0.08183
63	2.5	0.16775
88	2.5	0.32731
125	2.75	0.6604
177	6.25	1.32414
250	14.5	2.27604
354	22.5	3.33694
500	20.25	4.87879
707	10.5	7.14179
1000	1.75	10.4579

Table 5. Drilling muds fall velocity distribution (from Brandsma and Smith, 1999)

Particle Size (microns)	Percent Volume	Settling Velocity (cm/s)
3.7	1	0.0003
5.5	4	0.0006
8.6	19.2	0.0015
12.2	19.2	0.0031
14.8	13.3	0.0045
16	13.3	0.0053
17.9	10	0.0066
20.3	5	0.0085
46.5	8	0.0446
77.2	7	0.1222

3.3. Predictions of drilling discharge deposition

For both wells, cutting discharges are the primary component of the deposited materials; because of their relatively smaller particle size and their reduced discharge volumes, discharged mud only contribute to a small fraction of the deposition footprint; less than 10% of the total mass of the deposition above 0.01 mm corresponds to the deposited mud.

Well depth and distance to the shelf determine the current regime which is a combination of tidal currents and the more general and large-scale Mozambique currents. Tidal currents are stronger at shallower depth and their direction of flow is normal (perpendicular) to the bathymetry. Mozambique general currents flow mostly in a southerly direction, with current speed weaker near the shore and becoming significant near the shelf break. Deposition pattern of discharged sediments at each well site reflect this current regime.

As the Sofala-Charlie well is located in shallow waters (~30m) and far away from the shelf break, current near this well is mostly tidal. Sediments deposit around the well location spread in both an on- and off-shore direction without a clear net transport direction.

Since the M10-Alpha well is situated in deeper water (~100m) and much closer to the shelf break, currents are a combination of tides and the larger scale Mozambique currents flowing southward. Sediment deposits trend towards the south, following the predominant southern flow, but with a cross-shore component due to the tidal currents.

Table 6. Summary of predicted seabed deposition from drilling discharges

Thickness (mm)	Extent of the deposition footprint		Longest distance from the well site	
	M10 Alpha (km^2)	Sofala Charlie (km^2)	M10 Alpha (km)	Sofala Charlie (km)
0.01	4.627	2.372	2.2	1.6
0.02	3.118	1.492	2.0	1.2
0.05	1.506	0.885	1.2	1.0
0.1	0.653	0.594	0.8	0.8
0.2	0.085	0.354	0.2	0.6
0.5	0.042	0.127	0.1	0.3
1	0.025	0.052	< 0.1	0.2
2	0.015	0.025	< 0.1	0.1

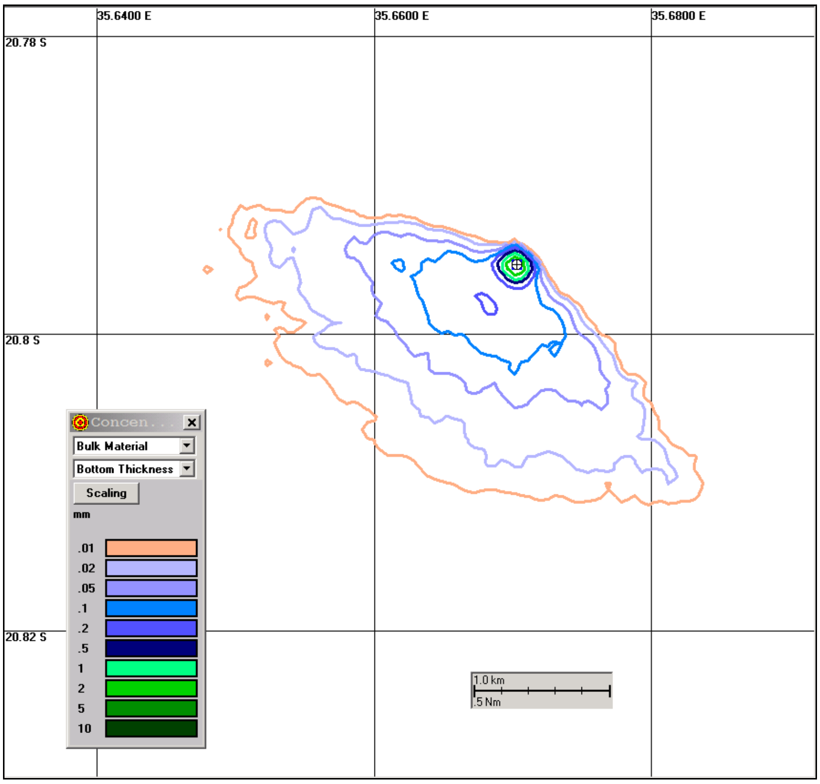

Figure 9. Predicted total accumulated seabed deposition thickness from M10-Alpha Well.

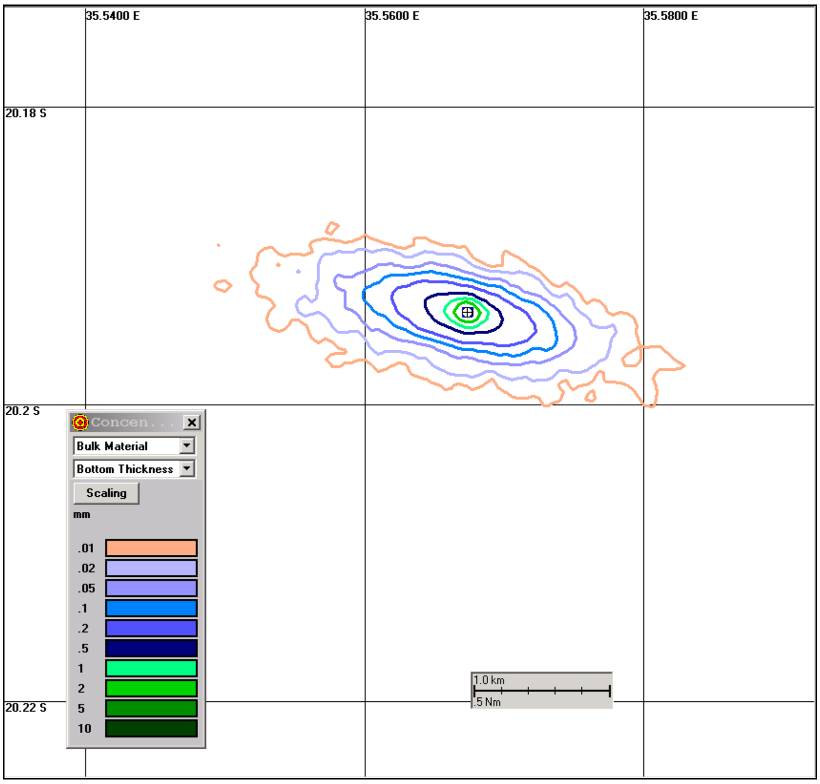

Figure 10. Predicted total accumulated seabed deposition thickness from Sofala-Charlie Well.

4. Surface Oil Spill Simulations

4.1. Surface Release Scenarios

Two potential spill events were defined by the client: a large blowout spill of condensate - a very light hydrocarbon, and a small spill of a heavy fuel oil (HFO).

The blowout event has been simulated assuming that the entire volume of the condensate released at the seabed will quickly reach the water surface generating a surface slick. The condensate blowout has been simulated as a continuous surface spill transported by winds and surface currents.

The spill site locations (Table 7) were chosen for their relative proximity to the coast and therefore higher probability for shoreline impact. Table 8 summarizes the simulations performed at two of the well sites.

Table 7. Location of the oil spill simulation well sites, Bravo and Delta.

Name	Block	Latitude	Longitude	Approx. distance to coast
Bravo	M-10	35° 31' 09" E	20° 41' 41" S	50 km
Delta	Sofala	35° 18' 34" E	19° 49' 08" S	20 km

Table 8. Scenarios of condensate and HFO spills.

Scenario	Location	Name	Period	Oil Type	API	Volume	Spill duration
B-BO	Bravo	Blowout	March-Nov.	Condensate	60	500 ton/day	2 months
B-HFO	Bravo	HFO small	March-Nov.	Heavy Fuel Oil	12	250 ton	Inst.
D-BO	Delta	Blowout	March-Nov.	Condensate	60	500 ton/day	2 months
D-HFO	Delta	HFO small	March-Nov.	Heavy Fuel Oil	12	250 ton	Inst.

The duration of the simulations has been defined as 14 days for the HFO spill and 68 days (2 months + a week) for the condensate blowout. The total amount of condensate to be spilled was 30,500 ton. Water temperature was assumed to be 26° Celsius which was the average value for the period.

The spill simulations were performed for the period March to November, as specified by the client, to correspond with the expected drilling period and outside the cyclone season.

4.2. Oil Characterization

Table 9 lists the characteristics of the oils used in the simulations. The physical oil properties provided by the client (API density) were supplemented with properties of an oil obtained from Environment Canada's Oil Properties Database (2006). Oil characteristics are summarized in Table 9.

Table 9. Summary of oil characterization data

Oil Type	API Gravity	Density (g/cm^3)	Viscosity (cP)	Surface Tension (dyne/cm)	Maximum Water Content
Condensate	60	0.7389	0.766	18.4	0%
Heavy Fuel Oil	12	0.9860	8706	32.5	35.0%

Viscosity and interfacial surface tension are used to determine the spreading of the surface oil, which in turn influences the rates of evaporation, dissolution, dispersion, and photo-oxidation. The maximum water content indicates the emulsion-formation tendency of the oil. Oils that form emulsions tend to be persistent on the water surface, thus increasing their shoreline impacts. The HFO has relatively moderate water content and emulsifies, and the 0% water content indicates that condensate does not emulsify.

4.3. Spill Modeling Approach

ASA's oil spill modeling system, OILMAP was used to simulate all spill scenarios.

OILMAP's stochastic and deterministic trajectory/fates models were applied to the spill scenarios:

- The stochastic simulations provide insight into the probable behavior of potential oils spills under the wind and current conditions expected to occur in the study area. The stochastic analysis provides two types of information: 1) sea surface areas that might be oiled and the associated probability of oiling, and; 2) the shortest time required for oil to reach any point within the areas predicted to be oiled. In addition, the simulations provide shoreline impact data expressed in terms of minimum and average times required for oil to reach shore, and the percentage of simulations in which oil is predicted to reach shore.
- The trajectory/fate simulations provide an estimate of the oil's weathering under particular environmental conditions. A deterministic trajectory/fate simulation is performed under a specific set of wind and current conditions identified in the stochastic analysis as resulting in significant impacts. This is typically defined as the simulation that predicts the shortest time for oil to reach shore, but can also be defined by other metrics such as the length of shoreline oiled, or the oiling of sensitive habitats. These simulations provide a time history of oil weathering over the duration of the simulation, expressed as the volume of spilled oil on the water surface, on the shore, evaporated, and entrained in the water column.

4.4. Stochastic Model Results

The OILMAP stochastic model was applied to predict sea surface probabilities of oiling due to oil and diesel spills described in the previous section. The stochastic analysis for each spill scenario is based on an ensemble of individual simulations, each with a different start time. Start times are selected randomly from within the specified season/period (winter or summer) during the ten-year wind record, thus sampling the variability in the wind forcing.

The sum of the sea surface trajectories from the individual simulations defines the expected water surface footprint for each spill scenario. This footprint represents the likely area of sea surface impact from a spill for that location and season. The probabilities of water surface and shoreline oiling and the minimum travel times for surface oil are provided for the area within the footprint.

The stochastic results provide insight into the probable behavior of potential oil spills under the wind and current conditions expected to occur in the study area during a given season. Only surface oil predicted to be thicker than 200 nanometers was used to generate the probabilities and minimum travel times shown in the figures. This is a conservative minimum thickness for surface oil that represents a barely visible slick. Results of the stochastic model predictions are presented in following Figures 11 to 18.

For each scenario, two figures are presented:

- Probability of surface oiling. This map shows the area in which sea surface oiling may be expected and the probability of oil reaching the area, based on the trajectories from the ensemble of independent simulations. The plot does not imply that the entire colored surface presented would be covered with oil in the event of a spill. The plot does not provide any information on the quantity of oil in a given area (water surface or shoreline); it only shows the probability that some oil reaches the area.
- Minimum travel times. The footprint on this map corresponds to the footprint on the probability map, and shows the shortest time required for oil to reach any point within the footprint based on the ensemble of independent simulations.

Table 10 presents a summary of the shoreline impacts for each spill scenario. The table gives the percentage of simulations in which oil was predicted to reach shore, the maximum and average amount of oil to reach shore and the minimum and average time for oil to reach shore.

Table 10. Summary of stochastic results from a potential blowout at Block Sofala and M-10

Scenario	Type / Spill volume	Simulations hitting shore (*)	Amount of oil ashore (Tonnes)		Time to reach shore (days)	
			Maximum	Average	Minimum	Average
Bravo - BO	Condensate 500 tonnes /day	87%	1565 (5%)	378 (1%)	1.6	18.4
Bravo-HFO	HFO 250 tonnes	91%	211 (84%)	181 (74%)	1.6	5.9
Delta - BO	Condensate 500 tonnes /day	100%	4575 (15%)	2063 (7%)	1.0	5.2
Delta-HFO	HFO 250 tonnes	98%	218 (87%)	204 (82%)	0.6	3.2

Note (*): only simulations leading to an impact of more than 0.1% of the total spilled mass are taken into account.

The following can be concluded from the results of the stochastic model simulations:

- Because of the proximity of the wells to the coast, all spill scenarios lead to a high probability (> 85%) of some degree of shoreline impact.

- Even though the total volume released in the condensate blowout scenario (30,500 tonnes) is far larger than the HFO spill scenario (250 tonnes), the percentage of predicted volume of condensate impacting the coast is much smaller (5-15%) due to its higher evaporation rate. At the end of the simulation, there is no condensate left in the water or on the shoreline.

- Spills from the Delta well have a higher chance of coastal impact with shorter times to shore due to the proximity to the coast and the predominant SE winds that push the pollutant towards the coast.

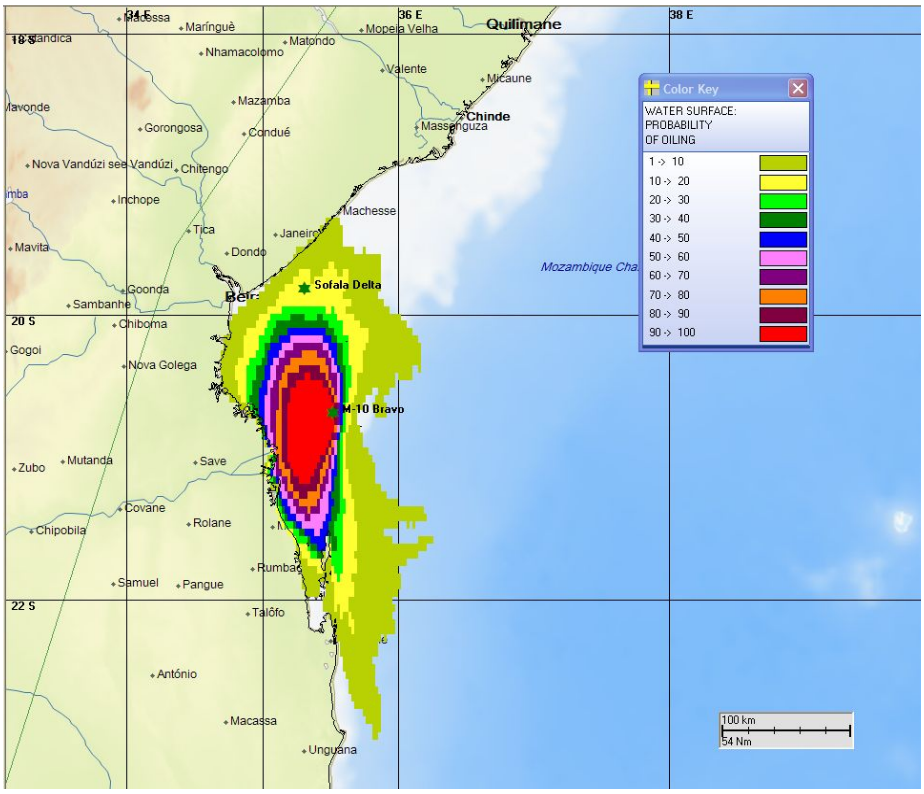

Figure 11. BRAVO - Condensate Blowout - Predicted probability of water surface oiling.

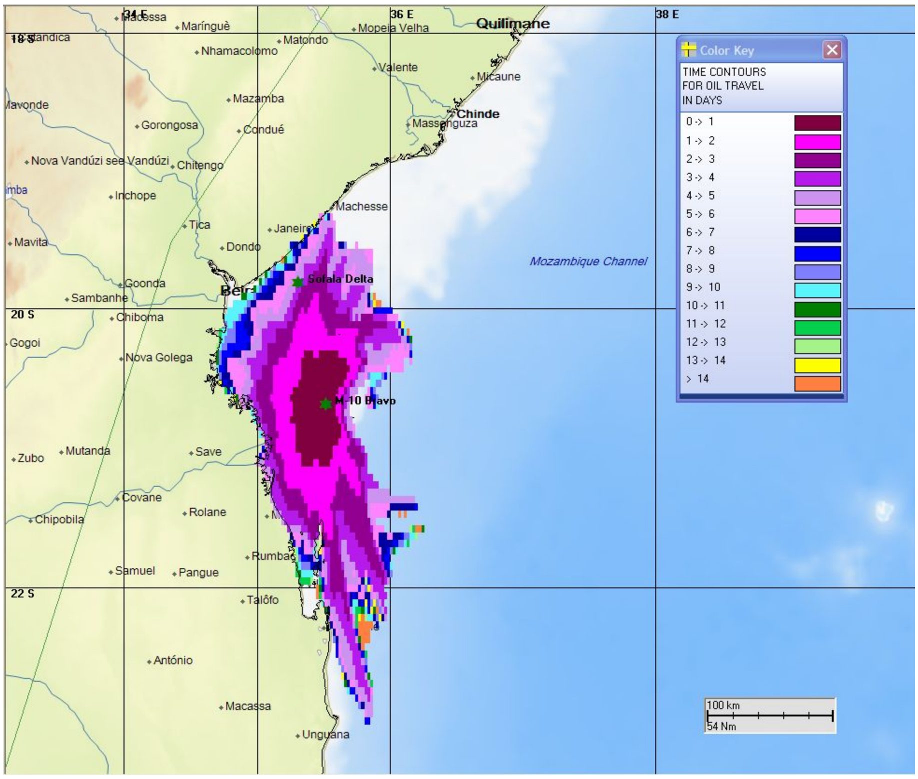

Figure 12. BRAVO - Condensate Blowout - Time contours.

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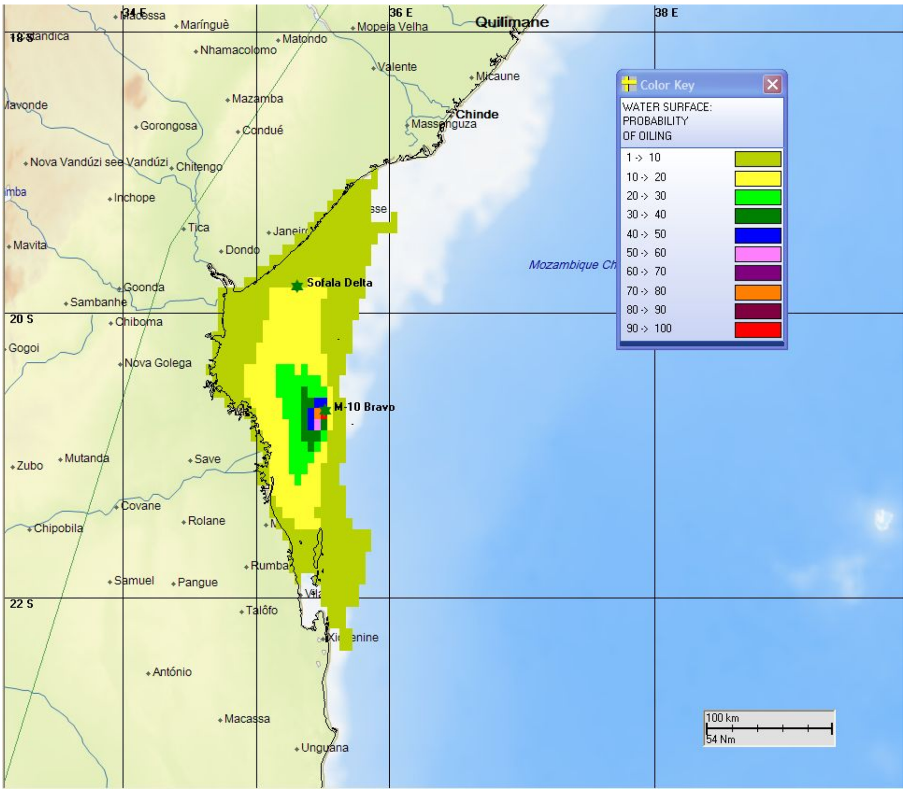


Figure 13. BRAVO - HFO spill - Predicted probability of water surface oiling.

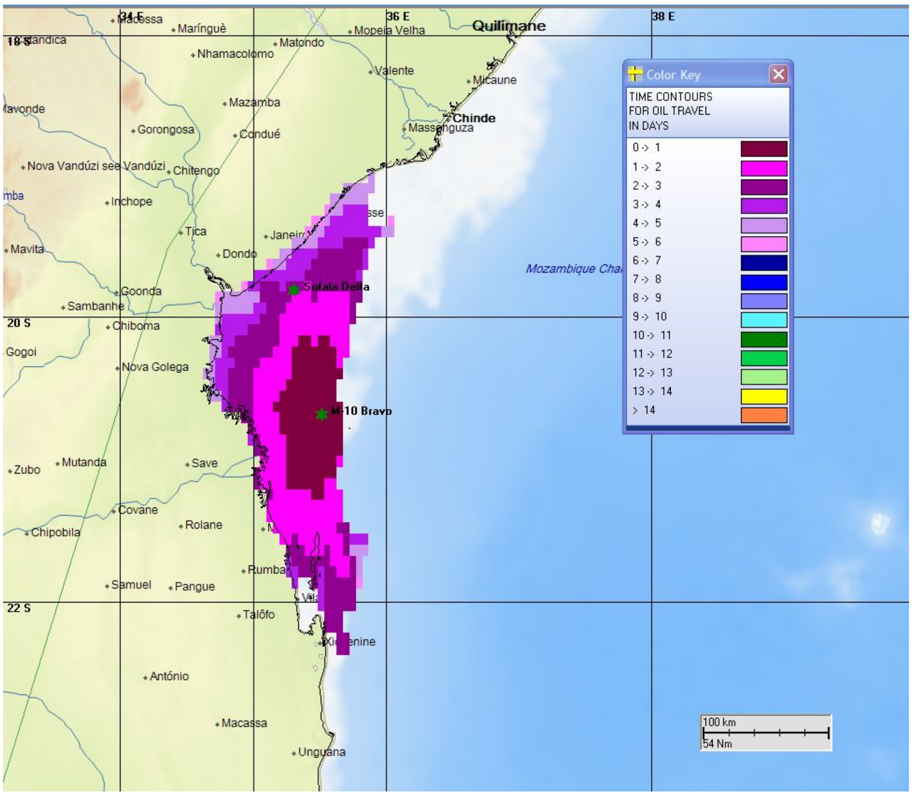


Figure 14. BRAVO - HFO spill - Time Contours.

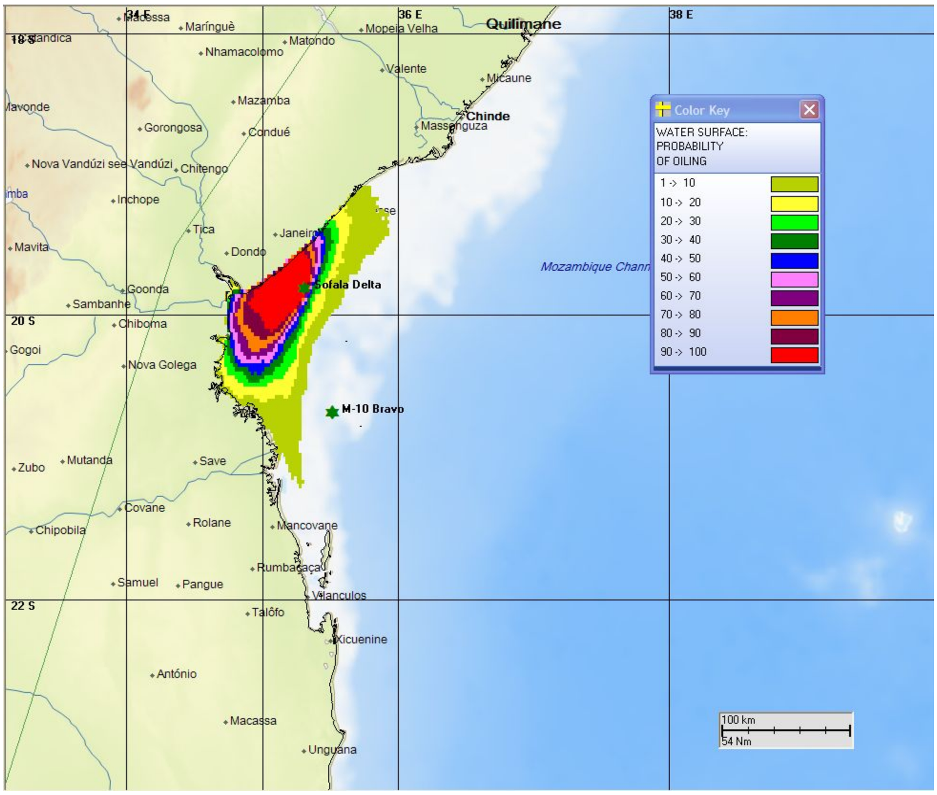


Figure 15. DELTA - Condensate Blowout - Predicted probability of water surface oiling.

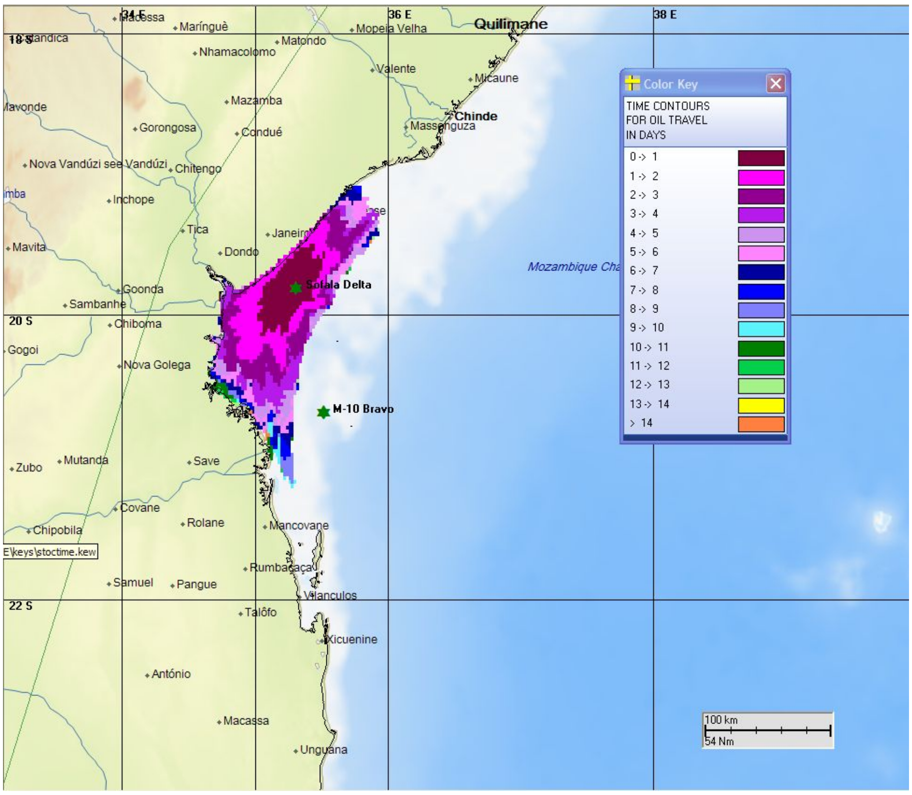


Figure 16. DELTA - Condensate Blowout - Time contours.

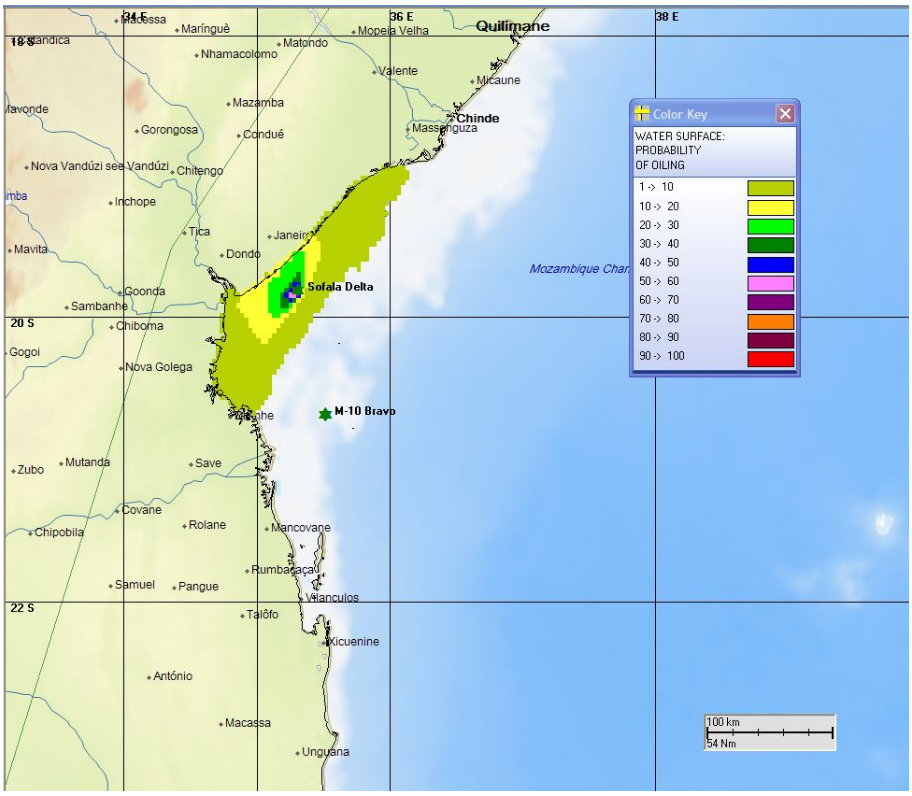


Figure 17. DELTA - HFO spill - Predicted probability of water surface oiling.

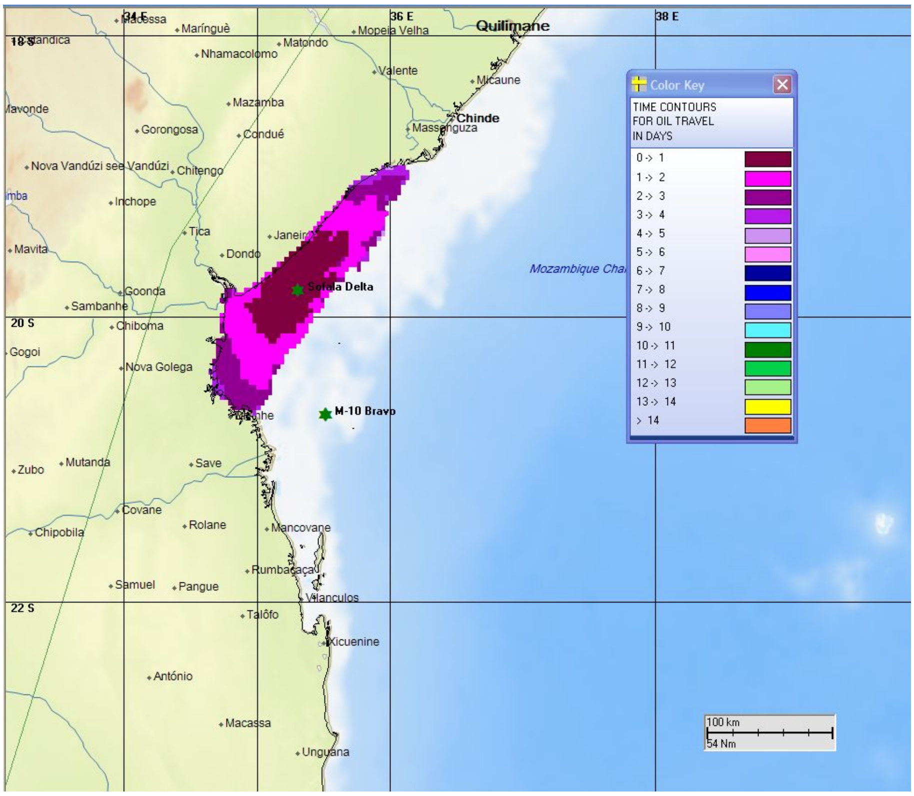


Figure 18. DELTA - HFO spill - Time Contours.

4.5. Deterministic Model Results

For each stochastic spill scenario, a deterministic trajectory/fates simulation was performed based on a representative simulation identified in the stochastic analysis that predicts significant shoreline impacts. The selected scenarios represent the worst wind and current conditions which result in maximum shoreline impacts.

The deterministic simulation provides a time history of oil weathering over the duration of the simulation, expressed as the percentage of spilled oil on the water surface, on the shore, evaporated, and entrained in the water column.

Results of the deterministic trajectory/fates simulations are shown in Figures 19-26. There are two figures for each spill scenario. The top figure on each page shows the footprint of the spill's trajectory on the water surface at the end of the simulation period. The oil-swept area is color-coded to indicate time since the start of the spill. A track line indicating mean oil position as the oil moves to shore is shown in black. The model-predicted mass balance for the spilled oil is displayed on the bottom half of the page. The mass balance graph shows the degree of weathering that the oil undergoes during the simulation period.

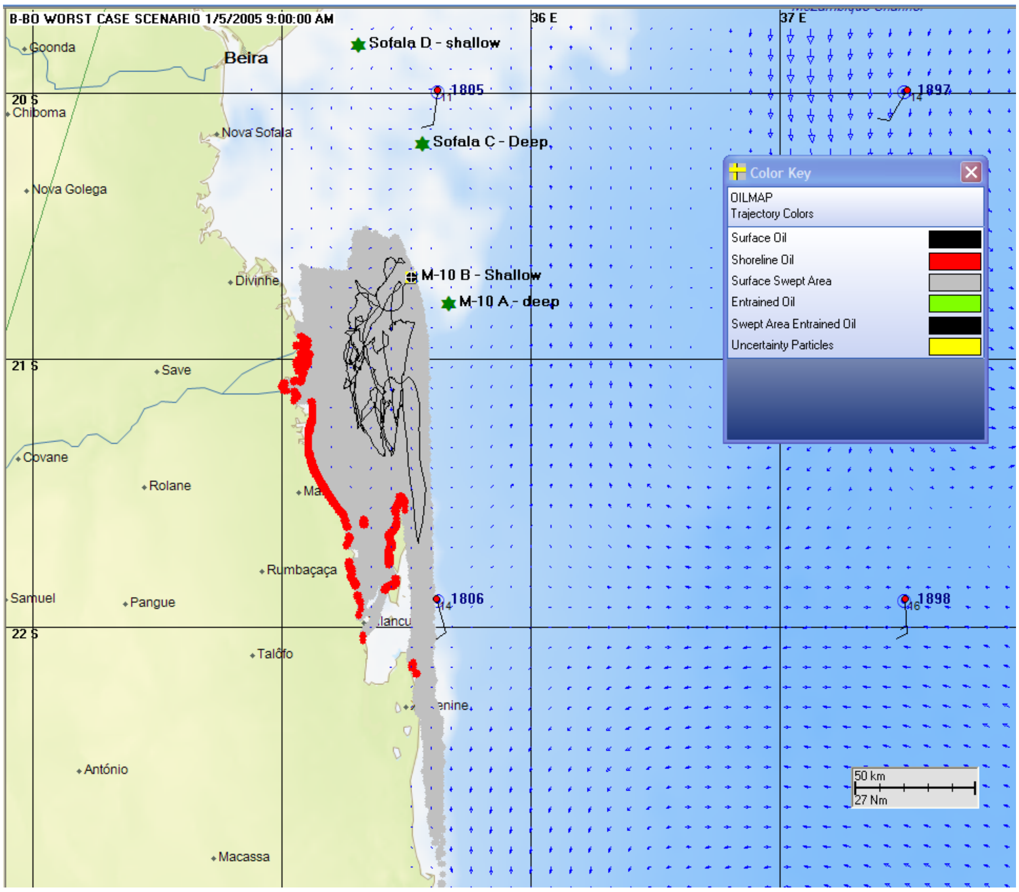


Figure 19. BRAVO - Condensate Blowout. Worst case model-predicted water surface signature. In grey is the swept area, in red shoreline impact. No surface oil remains after 68 days.

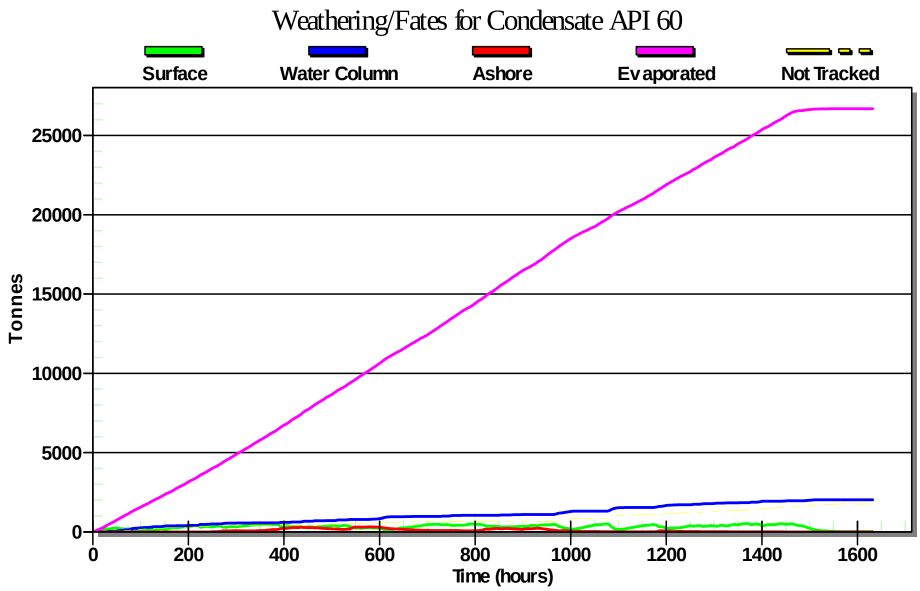
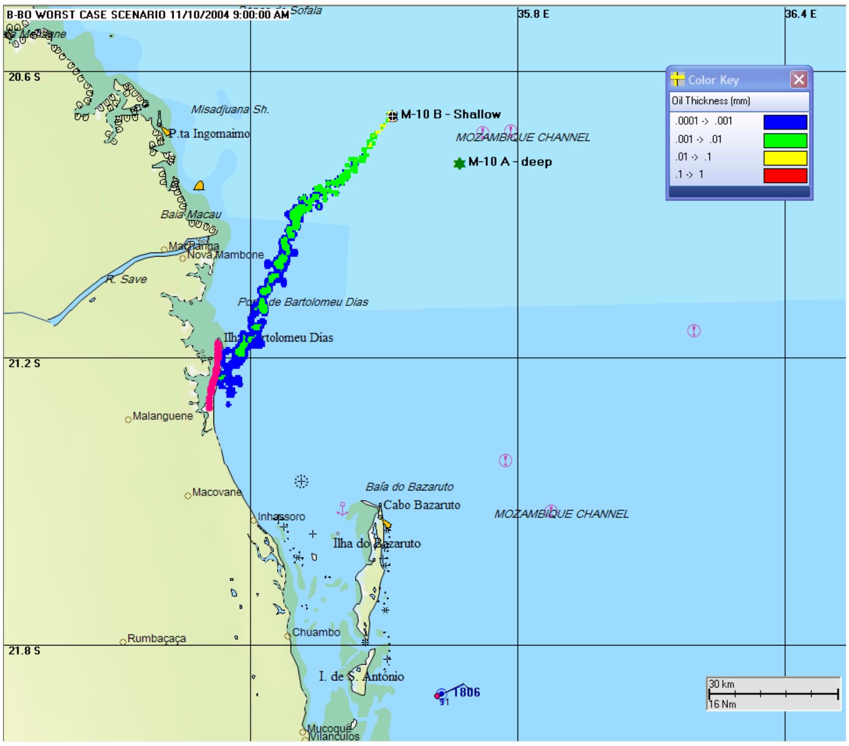


Figure 20. BRAVO - Condensate Blowout. Worst case model-predicted mass balance.



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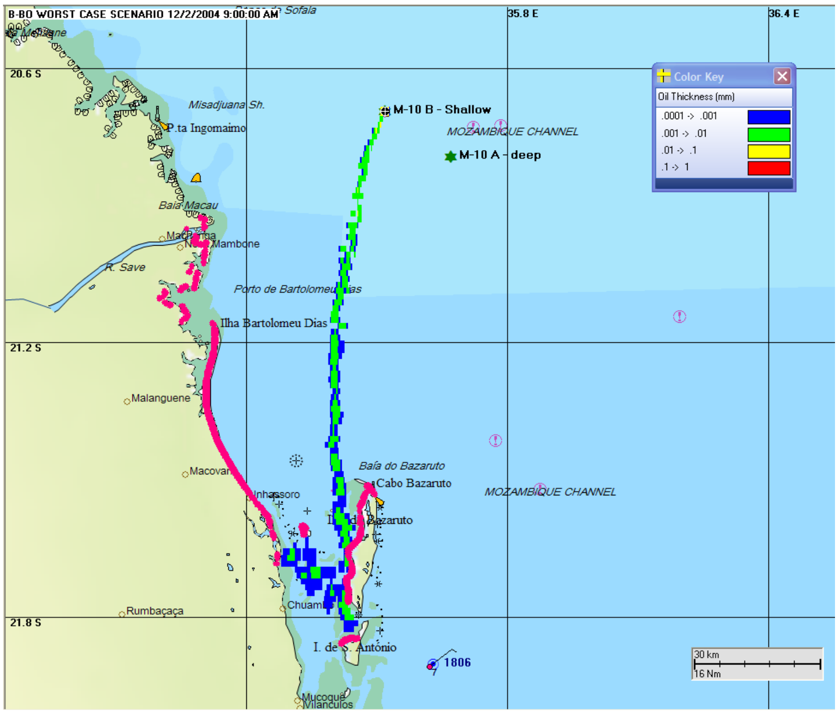

b)

Figure 21. BRAVO - Condensate Blowout. Worst case model-predicted condensate thickness contours at two different times since the beginning of the spill: a) 12 days later (first coastal impact), b) 33 days later. In pink, impacted shoreline. Any condensate remains on the water surface or in the coasts after 68 days.

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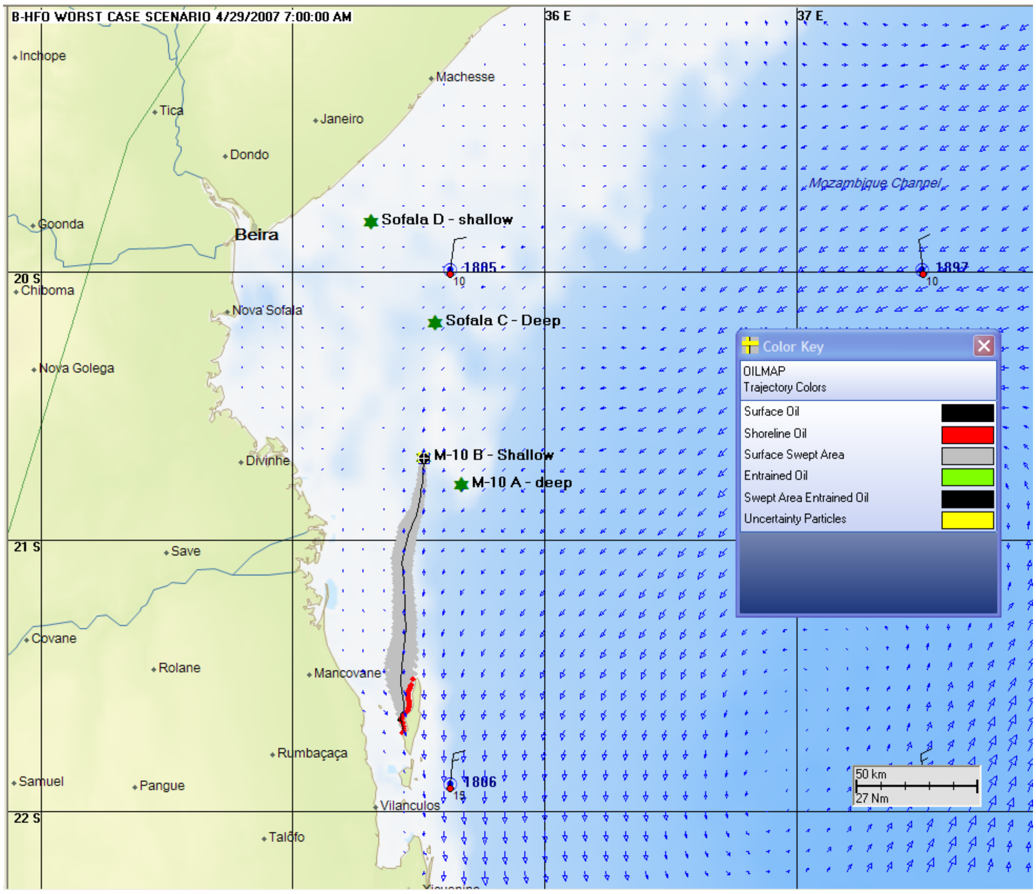

Figure 22. BRAVO - HFO spill. Worst case model-predicted water surface signature. In grey is the swept area, in red shoreline impact. No surface oil remains after 14 days.

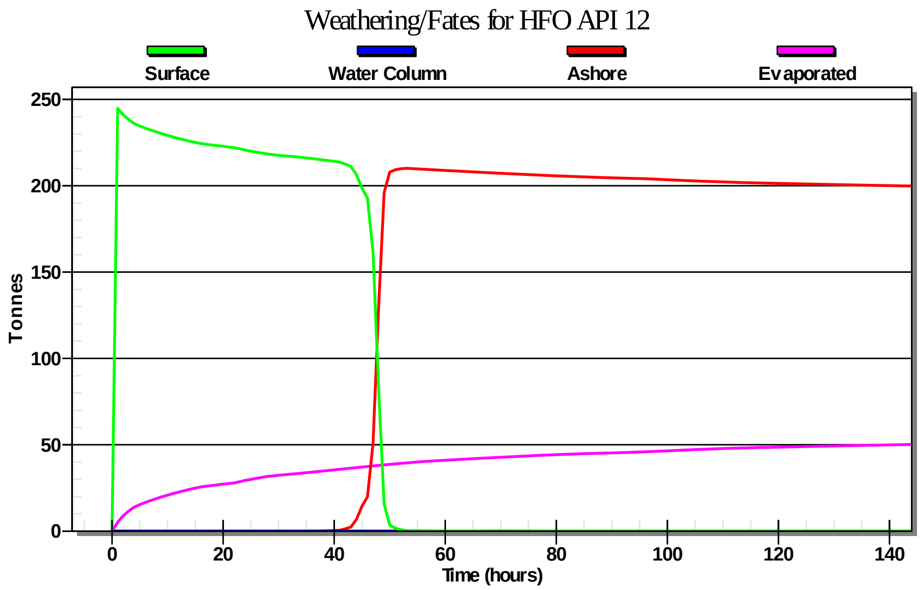

Figure 23. BRAVO - HFO spill. Worst case model-predicted mass balance.

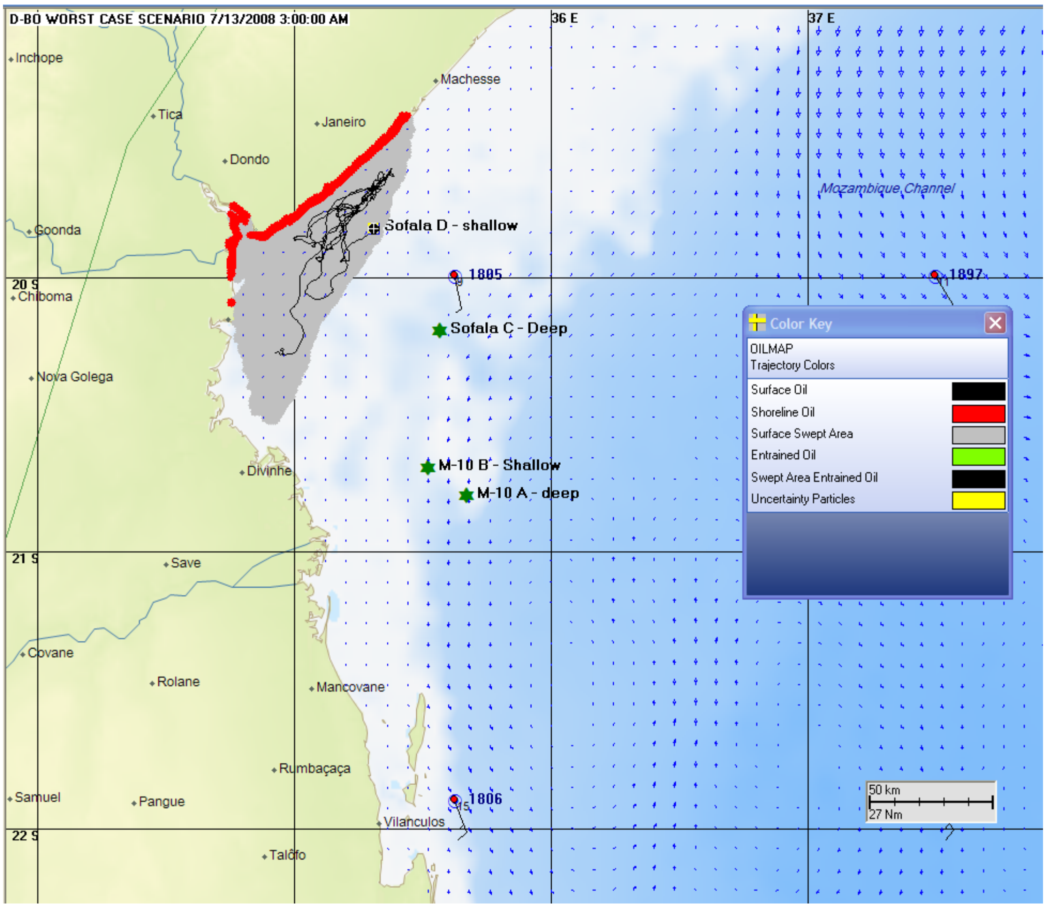

Figure 24. DELTA - Condensate Blowout. Worst case model-predicted water surface signature. In grey is the swept area, in red shoreline impact. No surface oil remains after 68 days.

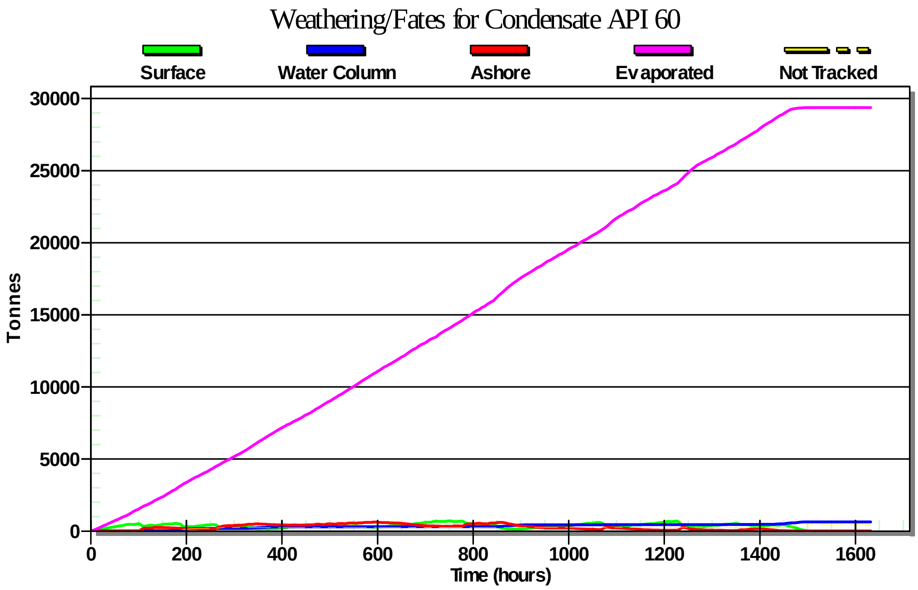

Figure 25. DELTA - Condensate Blowout. Worst case model-predicted mass balance.

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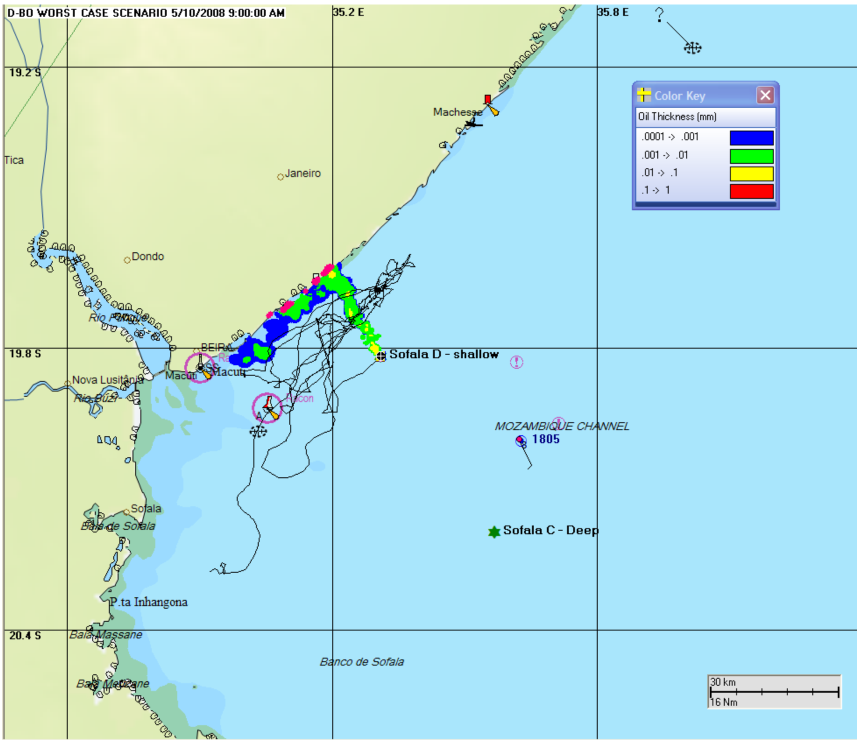

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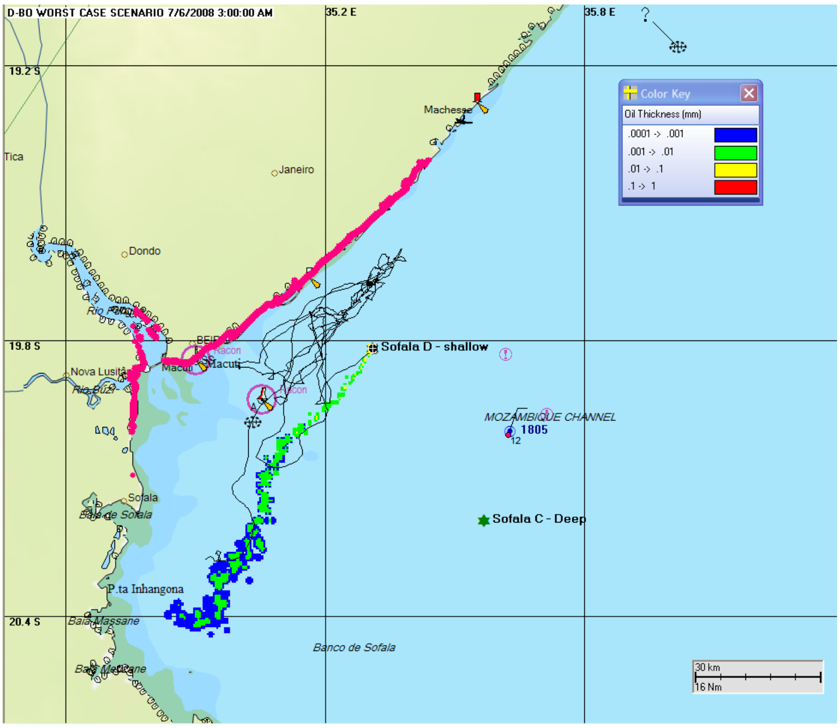

b)

Figure 26. DELTA - Condensate Blowout. Worst case model-predicted condensate thickness contours at two different times since the beginning of the spill: a) 4 days later (first coastal impact), b) 61 days later. In pink, impacted shoreline. Any condensate remains on the water surface or in the coasts after 68 days.

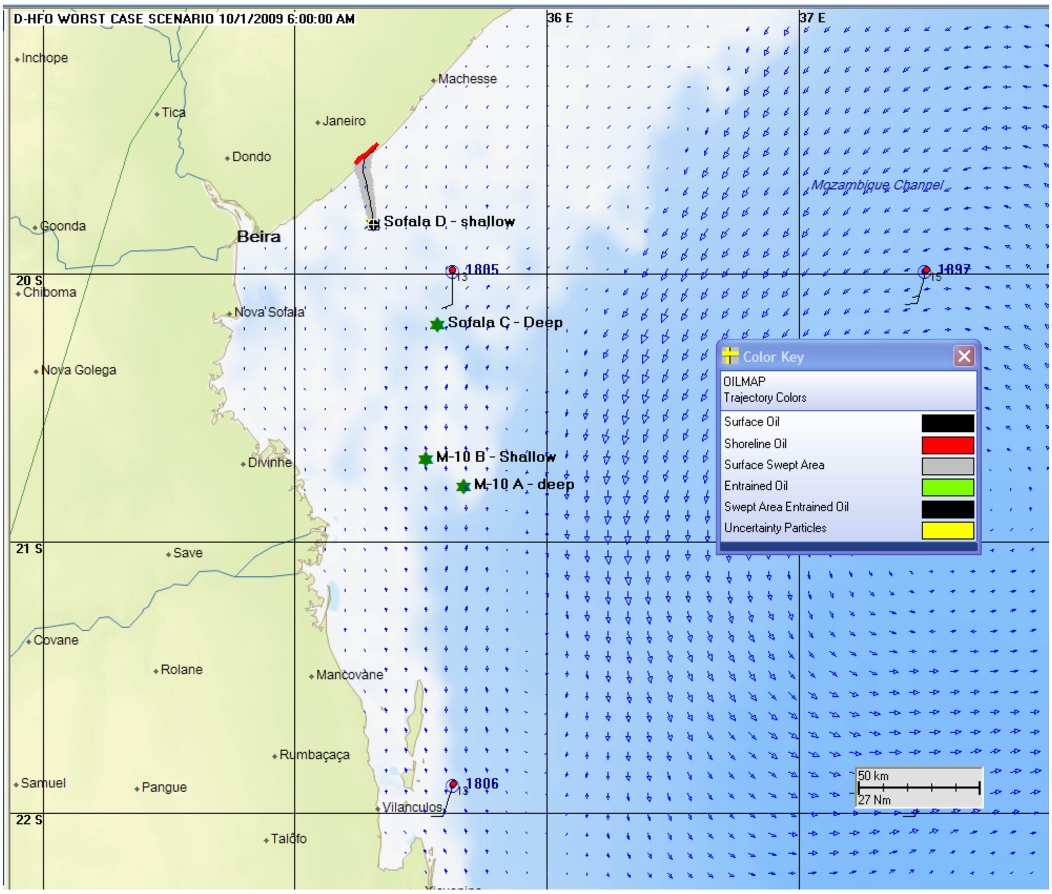

Figure 27. DELTA - HFO spill. Worst case model-predicted water surface signature. In grey is the swept area, in red shoreline impact. No surface oil remains after 14 days.

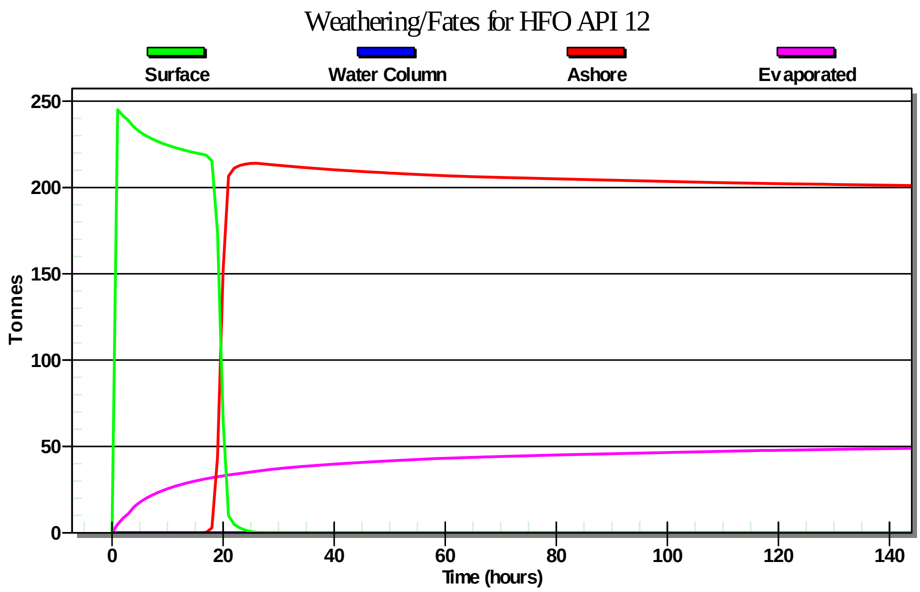

Figure 28. DELTA - HFO spill. Worst case model-predicted mass balance.

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5. Conclusions

This report presents the results from model simulations of spills of condensate and heavy fuel oil, and from simulations of drill cuttings and mud discharges from blocks M-10 and Sofala off the coast of Mozambique.

A basic climatological analysis was performed to determine the wind and current forcing in the area and these datasets were used as inputs to the models. Currents in the area of the wells are driven by shore-perpendicular tides and by the predominantly southward flowing Mozambique current. Large scale anti-cyclonic eddies move from north to south through the region several times a year and superimpose counter-clockwise flow patterns.

Drill Cuttings and Mud Discharge Simulations

- Discharges from the Sofala-Charlie well, which is close to the shoreline, are driven primarily by tidal currents and exhibit a shore-perpendicular orientation.

- Discharges from the M10-Alpha well, which is closer to the shelf break, are driven by a combination of tides and the larger scale Mozambique currents flowing southward. Sediment deposits trend towards the south, following the predominant southern flow, but with a small cross-shore component due to the tidal currents.

Stochastic Oil Spill Model Simulations

- Because of the proximity of the wells to the coast, all spill scenarios lead to a high probability (> 85%) of some degree of shoreline impact.

- Even though the total volume released in the condensate blowout scenario (30,500 tonnes) is far larger than the HFO spill scenario (250 tonnes), the percentage of predicted volume of condensate impacting the coast is much smaller (5-15%) due to its higher evaporation rate. At the end of the simulation, there is no condensate left in the water or on the shoreline.

- Spills from the Delta well have a higher chance of coastal impact with shorter times to shore due to the proximity to the coast and the predominant SE winds that push the pollutant towards the coast.

Deterministic Oil Spill Model Simulations

- All of the deterministic spills reach the shoreline. Because of the high evaporation rate of the condensate, a small percentage of the total spill volume actually impacts the shoreline. Shoreline oiling from the heavy fuel oil spills is predicted to exceed 200 tonnes and reach the shoreline within 1 to 2 days.

6. References

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Appendix A: MUDMAP Model Description

MUDMAP is a personal computer-based model developed by ASA to predict the near and far field transport, dispersion, and bottom deposition of drill muds and cuttings and produced water (Spaulding et al; 1994; Spaulding, 1994). In MUDMAP, the equations governing conservation of mass, momentum, buoyancy, and solid particle flux are formulated using integral plume theory and then solved using a Runge Kutta numerical integration technique. The model includes three stages: convective descent/ascent, dynamic collapse and far field dispersion. It allows the transport and fate of the release to be modeled through all stages of its movement. The initial dilution and spreading of the plume release is predicted in the convective descent/ascent stage. The plume descends if the discharged material is more dense than the local water at the point of release and ascends if the density is lower than that of the receiving water. In the dynamic collapse stage, the dilution and dispersion of the discharge is predicted when the release impacts the surface, bottom, or becomes trapped by vertical density gradients in the water column. The far field stage predicts the transport and fate of the discharge caused by the ambient current and turbulence fields.

MUDMAP is based on the theoretical approach initially developed by Koh and Chang (1973) and refined and extended by Brandsma and Sauer (1983) for the convective descent/ascent and dynamic collapse stages. The far field, passive diffusion stage is based on a particle based random walk model. This is the same random walk model used in ASA's OILMAP spill modeling system (ASA, 1999).

MUDMAP uses a color graphics-based user interface and provides an embedded geographic information system, environmental data management tools, and procedures to input data and to animate model output. The system can be readily applied to any location in the world. Application of MUDMAP to predict the transport and deposition of heavy and light drill fluids off Pt. Conception, California and the near field plume dynamics of a laboratory experiment for a multi-component mud discharged into a uniform flowing, stratified water column are presented in Spaulding et al. (1994). King and McAllister (1997, 1998) present the application and extensive verification of the model for a produced water discharge on Australia's northwest shelf. GEMS (1998) presents the application of the model to assess the dispersion and deposition of drilling cuttings released off the northwest coast of Australia.

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Appendix B. OILMAP Model Description

OILMAP is a state-of-the-art, personal computer based oil spill response system applicable to oil spill contingency planning and real time response and applicable for any location in the world (Jayko and Howlett, 1992; Spaulding et al., 1992a,b). OILMAP was designed in a modular fashion so that different types of spill models could be incorporated within the basic system, as well as a suite of sophisticated environmental data management tools, without increasing the complexity of the user interface. The model system employs a Windows based graphics user interface that extensively utilizes point and click and pull down menu operation. OILMAP is configured for operation on standard Pentium PCs and can be run on laptop and notebook computers to facilitate use in the field.

The OILMAP suite includes the following models: a trajectory/fates model for surface and subsurface oil, an oil spill response model, and stochastic and receptor models. The relevant models are described in more detail below.

The trajectory/fates model predicts the transport and weathering of oil from instantaneous or continuous spills. Predictions show the location and concentration of the surface and subsurface oil versus time. The model estimates the temporal variation of the oil's areal coverage, oil thickness, and oil viscosity. The model also predicts the oil mass balance or the amount of oil on the free surface, in the water column, evaporated, on the shore, and outside the study domain versus time. The fate processes in the model include spreading, evaporation, entrainment or natural dispersion, and emulsification. As an option OILMAP can also estimate oil-sediment interaction and associated oil sedimentation. A brief description of each process algorithm is presented here. ASA (1997) provides a more detailed description for the interested reader. The oil sedimentation algorithm is described in French et al. (1994), ASA (1996) and Kirstein et al. (1985). Spreading is represented using the thick slick portion of Mackay et al.'s (1980, 1982) thick-thin approach. Evaporation is based on Mackay's analytic formulation parameterized in terms of evaporative exposure (Mackay et al., 1980, 1982). Entrainment or natural dispersion is modeled using Delvigne and Sweeney's (1988) formulation which explicitly represents oil injection rates into the water column by droplet size. The entrainment coefficient, as a function of oil viscosity, is based on Delvigne and Hulsen (1994). Emulsification of the oil, as function of evaporative losses and changes in water content, is based on Mackay et al. (1980, 1982). Oil-shoreline interaction is modeled based on a simplified version of Reed et al. (1989) which formulates the problem in terms of a shore type dependent holding capacity and exponential removal rate.

For the subsurface component, oil mass injection rates from the surface slick into the water column are performed by oil droplet size class using Delvigne and Sweeney's (1988) entrainment formulation. The subsurface oil concentration field is predicted using a particle based, random walk technique and includes oil droplet rise velocities by size class. The vertical and horizontal dispersion coefficients are specified by the user.

Resurfacing of oil droplets due to buoyant effects is explicitly included and generates new surface slicks. If oil is resurfaced in the vicinity of surface spillets the oil is incorporated into the closest surface spillet. A more detailed presentation of the subsurface oil transport and fate algorithm is given in Kolluru et al. (1994).

The basic configuration of the model also includes a variety of graphically based tools that allow the user to specify the spill scenario, animate spill trajectories, currents and winds, import and export environmental data, grid any area within the model operational domain, generate mean and/or tidal current fields, enter and edit oil types in the oil library, enter and display data into the embedded geographic information system (GIS) and determine resources impacted by the spill. The GIS allows the user to enter, manipulate, and display point, line, poly line, and polygon data geographically referenced to the spill domain. Each object can be assigned attribute data in the form of text descriptions, numeric fields or external link files.

In the stochastic mode spill simulations are performed stochastically varying the environmental data used to transport the oil. Either winds, currents, or both may be stochastically varied. The multiple trajectories are then used to produce contour maps showing the probability of surface and shoreline oiling. The trajectories are also analyzed to give travel time contours for the spill. These oiling probabilities and travel time contours can be determined for user selected spill durations. If resource information is stored in the GIS database a resource hit calculation can be performed to predict the probability of oiling important resources.

OILMAP has been applied to hindcast a variety of spills. These hindcasts validate the performance of the model. Hindcasts of the *Amoco Cadiz*, Ixtoc and Persian Gulf War spills and an experimental spill in the North Sea by Warren Springs Laboratory are reported in Kolluru et al. (1994). Spaulding et al. (1993) also present a hindcast of the Gulf War spill. Spaulding et al. (1994) present the application of the model to the *Braer* spill where subsurface transport of the oil was critical to understanding the oil's movement and impact on the seabed. Recently Spaulding et al. (1996a) have applied the model to hindcast the surface and subsurface transport and fate of the fuel oil spilled from the *North Cape* barge. Integration of OILMAP with a real time hydrodynamic model and the hindcast of the movement of oil tracking buoys in Narragansett Bay are presented in Spaulding et al (1996b).

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Appendix C: Additional Drilling Discharge Simulations

Additional Discharge Conditions

This Appendix describes the modeling results of additional drilling discharge simulations performed in October 2010. Using the same well site locations (Alpha & Charlie), different discharge volumes were used and different types of drilling fluids were used in the modeling. Table 11 provides details of each drilling section, and the volumes and types of cuttings and drilling fluids to be discharged.

Two types of drilling fluids have been used: 1) a water based mud (WBM), discharged in large amounts during the first 3 drilling sections, and 2) a non-aqueous drilling fluids - NADF (NADF), specifically and Synthetic Oil Based Mud (SOBM), discharged in minor quantities, typically 5% of the cutting volumes in the two last sections.

Each type of mud leads to a different cuttings size distribution (Tables 13 and 14). As shown in figure 29, NADF generates a slightly more uniform size distribution of cuttings.

Table 11. Additional drilling discharge scenarios at Alpha and Charlie wells.

Sections	Diameter (in)	Depth (m)	Cutting Volume (bbl)	Cutting Volume (m^3)	Mud Volume (bbl)	Type	Discharge location
1	36	100	425	67.57	1,100	WBM	Seabed
2	26	200	440	69.95	3,300	WBM	Surface
3	17.5	700	700	111.29	2,700	WBM	Surface
4	12.25	2500	1,250	198.73	65	SOBM	Surface
5	8.5	1500	360	57.24	20	SOBM	Surface
	TOTAL	5000 m	3175 bbl	504.78 m^3	7185 bbl		

Table 12. Drilling fluids (mud) fall velocity distribution (from Brandsma and Smith, 1999)

Particle Size (microns)	Percent Volume	Settling Velocity (cm/s)
3.7	1	0.0003
5.5	4	0.0006
8.6	19.2	0.0015
12.2	19.2	0.0031
14.8	13.3	0.0045
16	13.3	0.0053
17.9	10	0.0066
20.3	5	0.0085
46.5	8	0.0446
77.2	7	0.1222

Table 13. Drill cuttings fall velocity distribution using WBM (provided by Client)

Particle Size (microns)	Percent Volume	Settling Velocity (cm/s)
1	1	0.00004
2	0.5	0.00017
3	1.25	0.00038
4	1.25	0.00068
6	1.5	0.00152
8	2	0.00271
11	2	0.00511
16	2	0.01082
22	1.5	0.02046
31	1.5	0.04062
44	2	0.08183
63	2.5	0.16775
88	2.5	0.32731
125	2.75	0.6604
177	6.25	1.32414
250	14.5	2.27604
354	22.5	3.33694
500	20.25	4.87879
707	10.5	7.14179
1000	1.75	10.4579

Table 14. Drill cuttings fall velocity distribution using SOBM (ASA)

Particle Size (microns)	Percent Volume	Settling Velocity (cm/s)
1.4	0.46	0.00016
2.0	1.28	0.00033
2.8	2.12	0.00064
3.9	2.9	0.00124
5.5	3.51	0.00247
7.8	3.85	0.00497
11.0	3.89	0.00988
15.6	3.78	0.01990
22.1	3.71	0.03993
31.3	3.71	0.08009
44.2	3.52	0.15971
62.5	3.07	0.31934
88.4	3.03	0.59450
125	4.68	1.09190
177	8.57	1.88890

(Continuation Table 14. Drill cuttings fall velocity distribution using SOBM (ASA, Ref. pending)

Particle Size (microns)	Percent Volume	Settling Velocity (cm/s)
…/…		
250	13.14	3.06390
354	15.29	4.77900
500	12.95	7.17390
707	4.77	10.40440
1000	1.14	14.64870
1414	0.38	20.05000
2000	0.14	26.37850
4000	0.11	42.95080

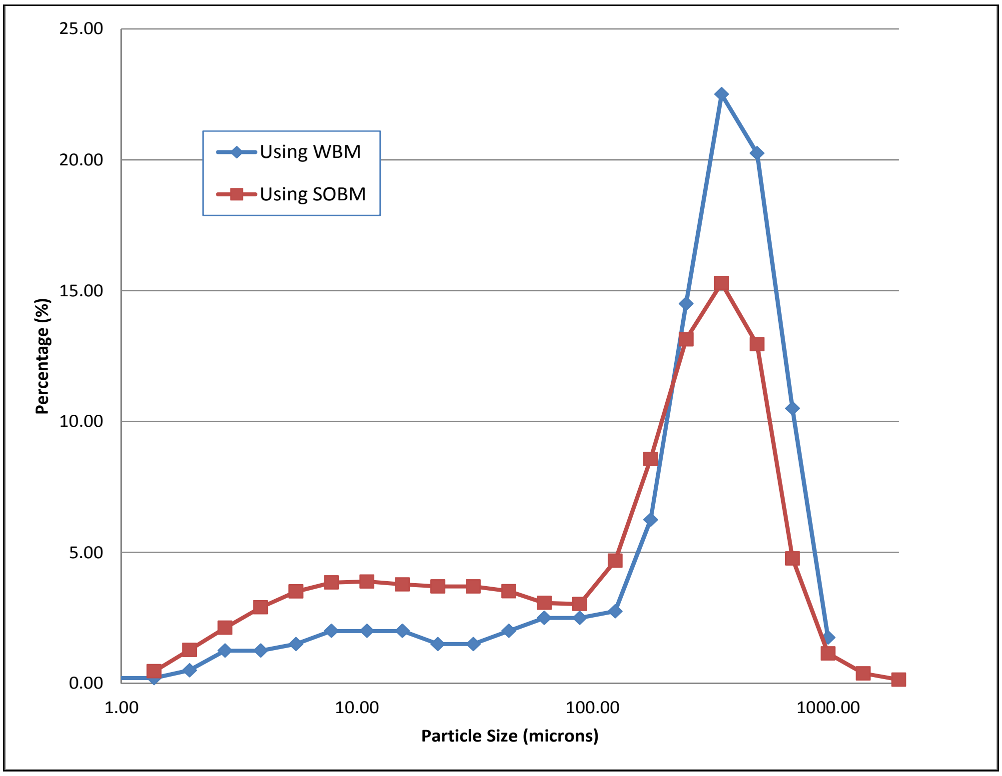

Figure 29. Comparison of cuttings Size Distribution using WBM and SOBM.

Predictions of drilling discharges depositions

For both wells, cutting discharges are the primary component of the deposited materials; because of their relatively smaller particle size, discharged mud only contribute to a small fraction of the deposition footprint; less than 17% of the total mass of the deposition above 0.01 mm corresponds to the deposited mud.

Similarly to previous simulations results, the deposition pattern of discharged sediments is related to the current tidal regime. As Charlie well is located in shallow waters (~30m) and far away from the shelf break, current near the well are mostly tidal. Discharged bulk material (muds and cuttings) from Charlie well deposits around the well location spreading in an on- and offshore direction. Alpha well is located in deeper water (~100m) and much closer to the shelf brake, hence currents are a combination of tide and the larger scale Mozambican currents. The discharged bulk material from the Alpha well deposits south side of the well spreading in a cross-shore direction due to the tidal currents.

Table 15 summarizes modeling results for these two additional simulations and Table 16 compares those results with the previous simulated scenarios (presented in Table 6). Overall, the footprint of the sediment deposition is slightly larger than in the previous simulations due to larger volumes of mud and cuttings discharged. Most significantly is the larger extent of the 0.01mm - deposition area due to a larger amount of discharged smaller particles compared with the previous simulation.

Table 15. Summary of predicted seabed depositions using a combination of WBM and SOBM.

Thickness (mm)	**Extent of the deposition footprint**		**Longest distance from the well site**	
	M10 Alpha (km^2)	**Sofala Charlie (km^2)**	**M10 Alpha (km)**	**Sofala Charlie (km)**
0.01	4.627	2.372	2.3	2.9
0.02	3.118	1.492	2	1.9
0.05	1.506	0.885	1.3	1.1
0.1	0.653	0.594	1.1	0.83
0.2	0.085	0.354	0.5	0.56
0.5	0.042	0.127	0.13	0.31
1	0.025	0.052	0.1	0.2
2	0.015	0.025	0.02	0.12

Table 16. Summary of predicted seabed depositions using a combination of WBM and SOBM.

	Previous Simulations (using only WBM)		Additional Simulations (combining WBM and SOBM)		Percentage increase (new / old simulations)	
Thickness	**Alpha**	**Charlie**	**Alpha**	**Charlie**	**Alpha**	**Charlie**
(mm)	(km2)	(km2)	(km2)	(km2)		
0.01	4.627	2.372	6.40	4.76	138%	201%
0.02	3.118	1.492	3.99	2.57	128%	172%
0.05	1.506	0.885	1.76	1.17	117%	132%
0.1	0.653	0.594	1.01	0.69	155%	116%
0.2	0.085	0.354	0.30	0.40	353%	113%
0.5	0.042	0.127	0.04	0.16	95%	126%
1	0.025	0.052	0.022	0.077	88%	148%
2	0.015	0.025	0.002	0.035	13%	140%

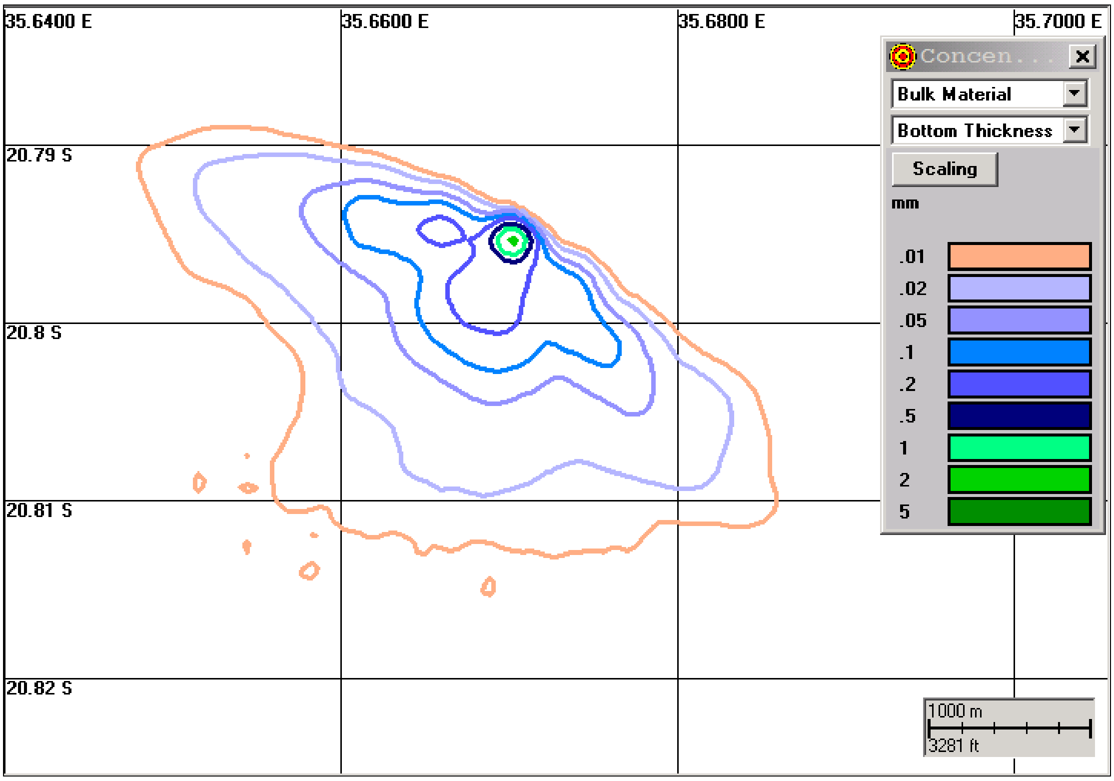

Figure 30. Predicted total accumulated seabed deposition thickness from Alpha Well using WBM and SOBM.

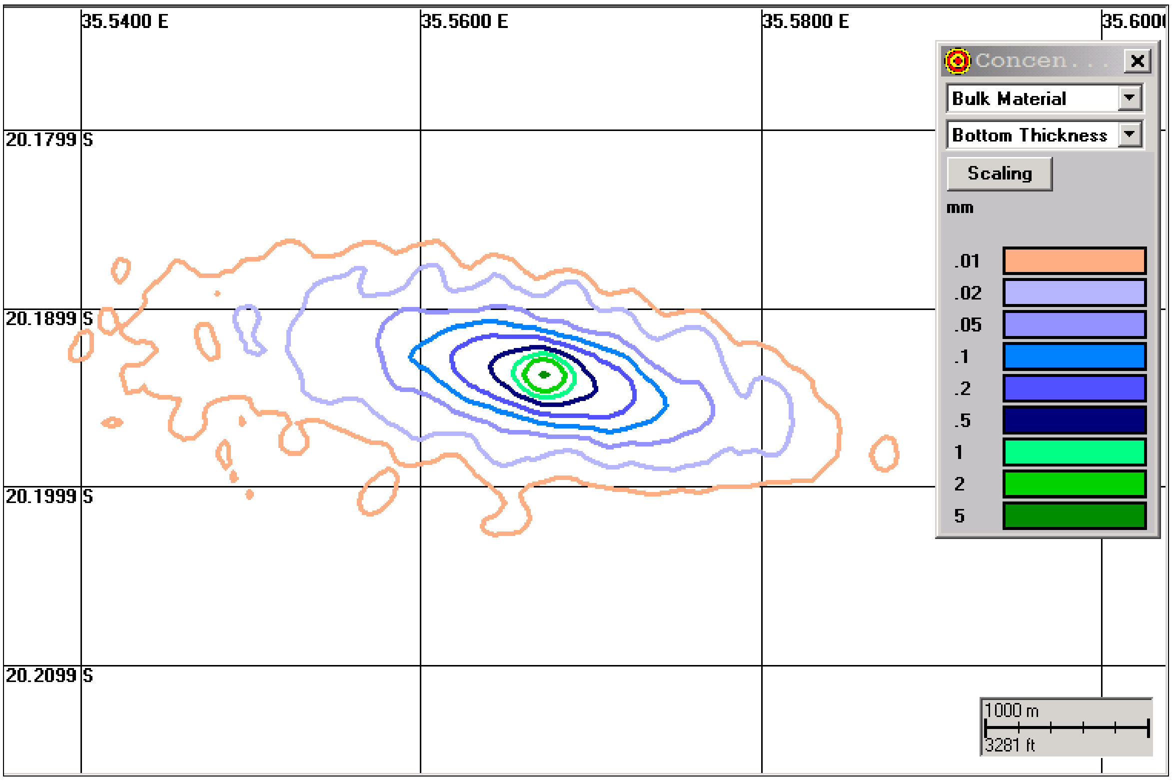

Figure 31. Predicted total accumulated seabed deposition thickness from Charlie Well using WBM and SOBM.

Annex D

Drilling Dispersion and Oil Spill Modelling: Blocks Sofala and M-10, offshore Mozambique.

Annex E

Public Participation: Notification and Scoping Issues

Table A. Meeting in Beira (23 August 2010)

ISSUES	RESPONSES
General aspects	
Jeque Marcos Augusto Sitole, Djalani Fishing Community Council What will the distance probably be between the Sofala coastline and the possible drilling sites, since these have not yet been identified?	The exact position of the drilling sites is not yet known. Four potential sites were selected (two in each Block) specifically to make an assessment of the dispersion models. They are not at all final sites, they were merely selected to include different types of environments in the context of the whole concession area. So, the position of each drilling site is not exactly known.
Nelson Velho, Cornelder On page 5 of the Non-Technical Summary it says "to confirm commercial quantities of renewable hydrocarbon resources", but I don't think that the use of the term "renewable" is adequate because hydrocarbons are not renewable.	Thank you. This aspect will be taken into account and revised.
António Mutondo, President of the Dondo District Fishing Community Council I would be grateful if during the exploration no fish is transported to another country, that you will limit yourself to what was granted, namely gas exploration.	Thank you. Comment registered.
Mateus Ribáue, Provincial Directorate of Tourism Is the offshore well drilling technique the same as the technique used on land?	The offshore drilling technique is almost the same as the technique used on land.
Mateus Ribáue, Provincial Directorate of Tourism In Sofala several studies were done regarding hydrocarbon exploration in Machanga, Muanza, Savane, Inhaminga, Cheringoma and the Zambezi Delta but until now we don't know the results, if there are hydrocarbons or not and which are the commercial quantities. I suggest that in the same way as the public consultation is done, the report of the exploration carried out in these areas should also be presented and made known to the local community and the provincial and district governments. It should not be a secret because there is no official information whatsoever yet. We	The only justification that exists for the fact that the communities and institutions have not been informed about the existence or not of hydrocarbons in commercial quantities is that no hydrocarbons were found in these areas. In principle each one of the proponents is responsible for communicating this information but this was possibly not done because no hydrocarbons were found. When Sasol last year found gas the company announced it publicly and so did Anadarko. However, we agree that the information should be given. The studies done in the areas referred to were not done by Sasol but by other companies.

ISSUES	RESPONSES
know that the studies were done by Impacto.	
Nelson Velho, Cornelder I would like to know which are the consequences of the withdrawal of a layer of gas or petroleum from the subsoil? The strata will be affected by the extraction of gas?	From the worldwide experience of similar activities there is no record or information of any area that has collapsed due to the extraction of gas or petroleum. And it is not expected that the extraction of gas in Mozambique will cause the collapse of earth.
Mateus Ribáue, Provincial Directorate of Tourism It was said that Sasol is interested in gas, but if it happens to discover petroleum in the same area, what will its attitude be?	The petroleum development process is different from gas. Petroleum and gas were formed millions of years ago by plant and animal matter. Gas and petroleum are formed in different temperature and pressure conditions. Sometimes both can be found, as is the case of Anadarko in the north. We hope to find gas as in Temane and Pande. Different processes will be used if we happen to find petroleum instead of gas and there will be different plans, depending on the quantities that are found. We cannot be specific in terms of the procedures to be followed, as these depend on the quantities and viability of the product found. It will also depend on the price on the international market, which changes constantly.
Jeque Marcos Augusto Sitole, Djalani Fishing Community Council What is the impact of petroleum drilling on existing submarine fibre-optic cables?	Some of the areas in which we did environmental impact studies for drilling projects were traversed by a fibre-optic cable and there were no incidents. But everything already indicates that the submarine fibre-optic cable does not traverse the Sasol concession areas (M-10 and Sofala blocks, respectively). Anyhow, before the drilling starts, there will be a machine operated by remote control, which will check the whole seabed in the area to see if there are obstacles. On the basis of this it can be determined if there is a fibre-optic cable or not, or any other obstruction. Before the drilling there is a pre-assessment of the drilling site.
Dispersion of drill cuttings	
Jeque Marcos Augusto Sitole, Djalani Fishing Community Council It was said that the drilling will result in the production of drill cuttings that may accidentally be dispersed into the sea. This will have a negative impact on the coastal area, mainly for fishermen, because it will scare away the fish along the coast and there	The vessel has a system for the separation of solids. The process will involve the use of muds that have a series of functions in the course of the drilling process, for example to help the bit to go down and regulate the pressure, and as the bit will perforate below it will bring with it what are called cuttings or pieces of rock. These cuttings are not

ISSUES	RESPONSES
will therefore be a serious fishing crisis for some time. Which mechanism is foreseen to control the dispersion of cuttings?	harmful, they come from the soil, from the environment. The only problem is that the cuttings may contain some traces, very small quantities of mud. But Sasol intends to use water-based muds and synthetic, non-oily muds. Synthetic or mineral muds will be used that are not harmful to the environment. A Waste Management Plan will be prepared that will determine what will be done with the cuttings.
Disposition and management of drill cuttings	
António Mutondo, President of the Dondo District Fishing Community Council Where will the drill cuttings be deposited during the activities?	A Waste Management Plan will be prepared that will determine what will be done with the cuttings. At this moment cutting dispersion models are being prepared that will help to determine the best disposal options.
Impacts of the drilling activities on the marine fauna	
António Mutondo, President of the Dondo District Fishing Community Council Are the cuttings not going to contaminate prawns and fish? And will this not cause a serious crisis in fishing?	We are in a pre-viability phase and do not yet bring the conclusions and impact analysis. The impact assessment is still to be made and the results will be presented when we will present the Environmental Impact Study in November. Thus, all impacts of the drilling project on prawns, fish, turtles and whales, on all activities, animals and plants will be assessed and presented in November. It has not yet been determined exactly if the drilling project will affect the fish.
Mateus Ribáue, Provincial Directorate of Tourism If by chance a hydrocarbon leak or spill accident occurs in the area, there is a concern that it will affect the existing marine fauna, whales and dugongs in this area, as well as the Bazaruto Archipelago National Park, also situated in the same area and created for the protection of dugongs.	The Bazaruto Archipelago National Park is situated at about 50 km and 100 km from the Sasol concession areas. Sasol has already carried out drilling activities much nearer the Bazaruto Archipelago and without any incident. We normally take the objective of the creation of the there existing Park into account, and which are its sensitivities. An analysis is made of each sensitive area existing in the proximity of the project. For the time being, the only possibility of the project affecting the Park, in this preliminary phase, is the occurrence of some hydrocarbon spill incident, which is not expected to happen. All these aspects will be taken into account in the study and we therefore decided to include the Bazaruto Park in our area of indirect influence. The decision to

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	have a large strip of coastal area for our studies is because we want to be sure that we will include all sensibilities existing in the area.
Impacts of the drilling activities on fishing	
António Mutondo, President of the Dondo District Fishing Community Council Will the fishermen be impeded to fish or not during the forty-five drilling days?	An exclusion strip of at least 500 metres will be established around the platform, during the about 45 days of drilling, to avoid for example collisions and other impacts and to try to avoid that these boats get too near the platform. However, the fishermen will be able to continue fishing in the remainder of the area outside the 500-metre strip. There will be a good communication system. The fishermen will be informed about the drilling sites and where the platform will be situated. Studies are being done and as much information as possible about the activities occurring in this area is being collected, on the coast and verify how these can be affected so that we can reduce impacts on these activities as much as possible. Sasol has already experience with Communication Plans. One of our biggest concerns, when operating on any project in or outside Mozambique is related to the relations with the communities. Sasol's previous experience in an extremely sensitive zone was in the Bazaruto National Park. What we do to ensure that all communities are de facto involved and receive prior information. We establish right at the beginning a communication office where we guarantee that all interested or affected people are part of this circle of communication and to this end we have a liaison officer for the relations with the communities and the fishermen. During drilling we will have a vessel in the 500-metre exclusion zone around the platform that will supervise this exclusion zone. In this vessel the officer liaison for the fishermen or the communities will be stationed and we guarantee that he/she will be a person who is able to communicate in the local languages to guarantee that the communication is efficient and effective. Thus, we will be sure that the people are

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	approached by this vessel calling attention to avoid coming near the platform communicating in the local language and that the people understand de facto what is going on.
Waste Management Plan	
	We will also have an office in Beira because our logistics will be done from Beira and we will have someone on land where everybody will have access to the daily reports of our operations. Impacto has accumulated experience in the preparation and implementation of communication plans, both in the seismic survey phase and in the drilling phase. We normally identify all fishing communities, villages and centres that will be affected, we create a field team to provide daily information to these fishermen about the position of the exploration vessel, in addition to the presence of a support vessel. We cannot present conclusions about the impact of the project on fishing, nor an assessment of the impacts in this phase because we are in a preliminary phase. We are collecting information of the area and are still making an assessment of the environmental impacts. We will present the results of these impacts in November when we come back. We are, for example, assessing if the noise will cause impacts on the fish, if the fish will flee or come closer, if the fish will ingest waste and have some problem, if the fact of having a 500-metre strip around the vessel will affect fishing or not. Means will be created to allow the provision of regular information to all artisanal, industrial and semi-industrial fishermen about the position of the vessel so as to minimize the impacts. All these impacts are still being studied.
Nelson Velho, Cornelder On page 6 of the Non-Technical Summary it says that two types of muds will be used, the synthetic and the water-based type. Regarding the synthetic mud, it was said that	We are aware that Mozambique does not have waste management facilities. One of the paragraphs of the Non-Technical Summary says that “the waste will be transported to the coast for final disposal”. This paragraph will be deleted, because in fact it is still

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waste management of this mud will be done, but what is noted is that this waste is sometimes sent to private entities and is not properly stored. I would like to know if, when this waste management is done, there are plans for its recycling or its disposal in other sites outside Mozambique, because as far as I know we don't have capacity at this moment to store waste nor to recycle it.	necessary to assess how all waste should be treated taking into account that Mozambique does not have these resources. Thus, the Waste Management Plan will determine how the process will be done. There are for example certain types of waste that can be discharged into the sea, such as the ablution effluents and others that can be treated by an onboard system, there are wastes that can be incinerated, and others can be transported to other countries or taken to our coast. All these possibilities will be assessed during the preparation of the Waste Management Plan.
Spills Contingency Plan	
Nelson Velho, Cornelder Has a contingency plan already been defined for cases of leaks? This plan should not only be defined theoretically, but also in practical terms and various entities should be involved in this contingency plan. I say this because in general contingency and emergency plans are defined but when a disaster occurs their implementation becomes a bit difficult because most of the plans have a theoretical basis and sometimes the contact numbers and spill containment actions are not viable. Beira City does not have any spill containment mechanism.	There is no contingency plan yet for petroleum spills. Plans have been prepared for previous projects and a dispersion model is being prepared, which in previous studies was done for a fourteen-day dispersion period. This period is now being extended to two months to guarantee that all impacts and areas that may be affected are properly studied. Thus, on this basis a specific plan will be designed for this project and the key institutions will be contacted in order that the Environmental Management Plan is feasible, and not only theoretical. Sasol is in the gas area and not in the petroleum area. Sasol's offshore exploration is to find gas and not petroleum. We will however consider all these hypotheses. For all diesel or mud spill levels there will be a written plan and all platform crew will have to read and know what is stipulated in this plan and should sign that they know what the plan says and they must comply to the letter with what is stipulated by the plan. Depending on the type of spill and if the spill is large the number of people involved will be larger, including the Port of Beira personnel, and if there is a justified need people at international level should also be involved. All this will be considered at the beginning and well before the possible occurrence of a spill and measures will be taken so that, if it happens, there can be an immediate response. The most important

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	aspect however is that there will be control measures in the final document to avoid the occurrence of spills.
Nelson Velho, Cornelder It is important that not only preventive measures are taken regarding possible spills or that the contingency plan is known by the people who are onboard or at local level, in the provinces or in the port but also that Sasol has containment means for possible spills or leaks. Taking as an example the spill that occurred a few months ago in the USA, everything was functioning perfectly well, all the plans had been prepared but there was a petroleum leak. It is therefore important to have containment means at provincial level because we don't have any containment means. It is important to have prevention mechanisms and we all know that they exist but it is much more important to have containment means in the case of a possible leak.	The issue of spills does not apply to this project because Sasol intends to explore gas and not petroleum. However, a detailed contingency plan will be prepared and will include a full implementation structure. We agree with the suggestion that not only those who are onboard the platform but also the institutions (Port, Maritime Administration, Fisheries, etc.) that by force of circumstance will be involved should participate in the harmonization of this plan and know it and be trained for the implementation of the plan. Because, if de facto something happens these institutions should be in the field.
Nelson Velho, Cornelder These projects give rise to doubts and distrust regarding how the Contingency Plan will be implemented or managed. It would therefore be good to create a mixed commission of technicians and others to visit the platform and check that everything what was mentioned is being implemented correctly in agreement with the provisions of this plan.	Thank you for the recommendation and we agree that the preparation and implementation of the contingency plan should be quite participatory and the institutions should be adequately involved. An implementation exercise of this plan can even be planned.
Glória Naene, National Institute of Disaster Management I would like to know which involvement is foreseen of the communities that may be directly or indirectly affected by said possible spills in the preparation and implementation of the Contingency Plan? I would like to manifest our interest in being allowed to participate in the preparation or implementation of the Contingency Plan.	Sasol foresees the involvement of the various institutions in the preparation of the contingency plan, including a direct intervention to assess the potential in terms of available and lacking equipment and what should be brought and the priorities to be defined in the plan.
Water quality	
Murate, Provincial Directorate of Health, Environmental Health Department	When referring to the impact on water we mean seawater, as we refer to all discharges

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On page 91 of the EPDA report reference is made to the impact on water but it does not say if this concerns seawater or potable water.	of all activities resulting from the vessel's operation (deck water, ballast water, ablution water, potential discharges of waste that is allowed to be cast into the sea) and we will assess what impacts these discharges may cause on the quality of the seawater, for example if there will be an increase of turbidity.
Socio-economic issues	
Murate, Provincial Directorate of Health, Environmental Health Department The Non-Technical Summary refers to all aspects except human health. It refers to the environment, fishing, but not to the surrounding population.	The socio-economic studies will also include health. For example, if there is a spill, how it will affect the fish and how this fish may affect the health of the population.
Social projects	
Nelson Velho, Cornelder We all know that when there is economic investment in a certain area the Government requests the investor company to make a contribution to the local population or community living in this area. In indirect terms we know that there will be a contribution in terms of employment and the logistics that will be done from the Port of Beira. In direct terms we would like to know which contribution Sasol will make to Beira City or Sofala Province.	Sasol has a sector in its strategy dealing with its social responsibility. In principle, when Sasol entered the Mozambican market, still in the project phase, it did some work in the social area in Sofala Province, specifically in Machanga District. At this moment we are concentrated on the operational areas, with greater emphasis on the Pande and Temane areas, in Inhassoro and Govuro Districts. I cannot say if in this phase of the project something will be done in social terms. We are in the exploratory phase and if gas is discovered in commercial quantities this area will become an operational area and we will have activities materialising our social responsibility.
Availability of information	
Jeque Marcos Augusto Sitole, Djalani Fishing Community Council The distribution of the EPDA reports should not be limited to the provincial directorates, but should also cover the community structures, because we cannot leave the fishing areas and go to the institutions to consult the document. For the next meetings we would like to ask you to have reports available for distribution according to the number of participants.	We will take this aspect into account in the next phases. However, the first document sent to the public was the Discussion Document and it was sent to everybody on the preliminary list of interested and affected parties. The Non-Technical Summary that was sent now, was also distributed to everybody on this list and to others subsequently identified. We regret the delay occurred in delivering the documents locally but the documents were sent to the districts to be handed over to the communities, not to everybody but to the representatives of the consultative councils, fishermen associations,

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	etc. We will try to cover the largest possible number of people.
Communication Plan	
Arlindo Miguel Faustino, National Hydrographical and Navigation Institute (INAHINA) On the basis of your experience with other projects, which signalling and communication method with the boats will be used, since traffic in the Port of Beira is very heavy and many fishermen do not even have a radio to communicate? Perhaps the solution is to use light signals, which is the method used by us and the fishermen in our channels.	Regarding communication we will make use of the positive experience we already have from other projects. There is communication at the level of the navigation control institutions to allow information via radio, there is direct information to the fishing centres about the activity. Thus, a complete mechanism has been created to cover the boats that have radio communication as well as all the artisanal fishermen who do not have these instruments but who need to have this information. Before the arrival of the platform a notice to navigation will be sent to institutions such as INAHINA and INAMAR, which will transmit the information to other ships entering the area and subsequent information will also be given about where the platform is operating and the exclusion strip. Additionally, while the platform is operating at night it will be properly illuminated and it has various warning and prevention mechanisms to avoid collisions. Meanwhile, there will also be a support vessel, which will be circulating around the exclusion zone, also to inform about the distances regarding the approach of the exclusion zone, and the environmental officer for communication with the fishermen will inform even those fishermen who don't have a radio. Thus, the information will be given before the start of the drilling activities so that the fishermen will know where the platform is and that they should respect the 500-metre strip.
António Mutondo, President of the Dondo District Fishing Community Council I suggest that the communications are done between 18 and 19 hours, because at this time the fishermen have already returned home. I also suggest to use Radio Mozambique as it is has a wider coverage. Communication should be done in three	Thank you. We will retain this information and take it into account during the preparation of the Communication Plan.

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languages: Portuguese, Sena and Ndau.	

Table B. Meeting in Maputo (24 August 2010)

ISSUES	RESPONSES
General issues	
Jafar Ruby, National Hydrographical and Navigation Institute I think that on page 5 of the Non-Technical Summary, regarding the period of the occurrence of cyclones, there is a mistake because the April to November period is mentioned and in fact it is the contrary, it is from November to April.	Thank you for your observation, we will correct the data.
Rui Minir, IUCN I would like to know which is the area or radius of direct influence of the project?	Since we don't know yet the exact drilling sites, we consider the entire area within the blocks being the project's area of direct influence. The area of direct influence of block M-10 is 3400 km², which is the block M-10 concession area. In the case of the Sofala block it would be about 8614 km². Regarding the area of indirect influence we decided to select from each one of the limits of the concession to the coast and from the Bazaruto Park until the Zambezi River, so as to cover as much as possible the environmental and socio-economic conditions also existing on the coast.
Joaquim Russo de Sá, Ministry of Fisheries It is referred in the document that near the Sofala Bank the most abundant crustacean is prawns but in fact the Sofala Bank is the prawn bank.	Comment registered.
Drilling site	
Joaquim Russo de Sá, Ministry of Fisheries Though we know that previous and similar activities have already been carried out, our concern is related to the localization of the project and the Sofala Bank. It is important to take into account that more than 75% of the national fisheries production comes from the Sofala Bank. When we talk about the Sofala Bank we refer to the artisanal fisherman to deep-sea fishing, which is done at depths of more than 20 metres, through deep-sea crustacean fishing.	Exploration is an industry in which we try to find new deposits of petroleum or gas. The success rate is normally 20 to 30%. This means that there is a 70 to 80% probability of not finding anything. Due to this it is very difficult to determine exactly the site where we should drill and we use the seismic survey to identify the best sites to drill. Hydrocarbons are found at different depths in the ground. For example, in Pande and Temane, on the coast, the depth of the hydrocarbons is about 1800 metres and in terms of seismic survey we are doing offshore exploration. We have identified some high-risk prospects at depths of about 1800 to 2000

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If it would be possible to have an idea of the site of these drillings, even if at a reasonable scale, it would be important for those who are responsible for the management and distribution of the fishermen.	metres. We have however also identified some greater-risk prospects at greater depths than these and we are now in the process of assessing the risk and the possibility of finding or not hydrocarbons and the cost of drilling these very deep wells. As soon as we have concluded this assessment we will make a classification of the risks and those sites with a larger probability to find gas or petroleum will be drilled. Drilling is also limited to the availability of a platform, in this case a "jack-up rig", in shallow waters until a depth of 15 metres. The platform is unable to reach these depths because the waters are very shallow. Meanwhile, this type of platform can also not operate at depths of more than 100 metres. And because we are still making this assessment and we have restrictions as to until where the platform can reach, we are still trying to find the best drilling sites. Thus, I don't think that we will be drilling in the area of shallow waters and we will also not drill in very deep waters. We have two potential sites in each one of the blocks that were only identified to do the cutting and hydrocarbon dispersion models. When we will know the exact sites we will prepare an Environmental Management Plan specific to the site and depth at which we will drill.
Number of wells to be drilled	
Joaquim Russo de Sá, Ministry of Fisheries In relation to the project we are concerned that we don't know how many wells will be drilled, because we want to avoid that in the high fishing season we would have to divert or to order the withdrawal of fishermen from the area where by coincidence there will be a well. Even with the situation you are expecting it is necessary to take into account that fishing is an activity in which what is not produced today, tomorrow will not be found on the same site.	The number of wells we want to drill will depend on the amount of petroleum or gas we find. However, we have to drill a well in the M-10 block and a well in the Sofala block in agreement with the contract signed with the National Petroleum Institute and the respective Ministry. The biggest part of the cost related to well drilling has to do with the process of bringing the platform to the drilling site and afterwards taking it out again. Thus, due to this it is more cost-effective and viable to drill the largest possible number of wells at one go. But on the other hand the drilling of each well is very expensive and there are cost limits. Realistically we will drill a single well in each exploration period of the licence and possibly two wells at the most per licence for the exploration phase.
Drilling period	

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Joaquim Russo de Sá, Ministry of Fisheries The other issue has to do with the duration of the project, with the part of the year. The season that is being suggested is from April to June and coincides with the fishing cycle season, mainly of prawns. The biggest prawn cycles are in April and May and it decreases abruptly, more than 50%, from June, July, August. If it would be possible to start in the second half of the winter, it would be excellent for fishing, but from what we read in the document received this does not seem to be very possible. So, this not being possible we suggest that drilling is done after June, to avoid a conflict with the high season. Though no longer today, prawn fishing is very important (accounting for 50% of the total value of exports of this country), at an important level in the country's economy, mainly regarding exports. The issue is that we can only limit ourselves to the document we have received and to the area shown on the map. If you say that you will not drill in the yellow-coloured area representing semi-industrial fishing it is excellent, but for us it is the whole area indicated and we are referring to this area. On the other hand, we understand all the reasons for which it is difficult to specify the period and the number of wells that will be drilled. However, the only issue we present here is to consider, if possible, to drill the wells after June, which is not yet the cyclone season, to allow that no disturbance occurs in the most productive fishing period.	For each drilling there is a period with which we have to be very careful, namely the cyclone period. For security and environmental reasons we don't want to have an offshore drilling platform operational in these conditions. On the other hand, it is very difficult to foresee when a drilling platform will be available, since we depend on the company that was previously using the platform somewhere else in the world. They first have to conclude the operations and only after this are available for the next client. For example, for blocks 16 and 19 we had planned everything to start drilling in June. The platform however only arrived in October. We will do what we can when we ask for the platform but a drilling platform costs about 170 thousand dollar per day, so that when the platform arrives we cannot simply let it wait. On page 6 of the Non-Technical Summary it says that "drilling is expected to be done after July". When April and June are mentioned, this refers to the occurrence of cyclones in the area. We would like to recall that fishing can continue to be done during the drilling period, except within the 500-metre strip around the platform. Outside this area fishing can be done at any time of the year.
Environmental Impact Study – Biophysical study	

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Joaquim Russo de Sá, Ministry of Fisheries In the ecology section the demersal species, which are caught through line fishing, are not referred to, contrary to the demersal prawn species that are caught by trawling. In the marine ecology section it is important that all species and all fishing activities targeting these species are referred to through the designations known by us. The document refers to two types of prawns, shallow water prawns and surface prawns. We do not know if these are two types of prawns or if it is the same with the same designation.	We thank you for the contribution and we will use it to improve the document. We will contact the fisheries specialist to pay attention to these issues when preparing his/her study.
Impact of the project on fishing	
Joaquim Russo de Sá, Ministry of Fisheries What is important to take into account in the coastal area, and which has not been done in the Non-Technical Summary, are semi-industrial prawn fishing with the use of ice, hand line fishing, which wasn't mentioned anywhere, and deepwater fishing of crustaceans. These are the three fishing areas for which we think that any intervention may become a problem and we are talking about a universe of about 25 to 30 semi-industrial boats, 10 industrial boats and over 5000 artisanal fishermen in the whole area.	The document distributed to the institutions is a small summarised document. The EPDA report gives more information about the various types of fishing practised in the area, but a study is being done especially focussing all types of fishing activities in the region and mentioned by you. We will guarantee that all these activities are included in the Environmental Impact Study and that the impacts of the project on these activities will be assessed.
Joaquim Russo de Sá, Ministry of Fisheries The fishing camps here referred to are those situated on land and will not have any problem. The problem is for those who will have to go out fishing at sea, where the drilling activities will take place.	Thank you. Comment registered.
Joaquim Russo de Sá, Ministry of Fisheries It is also important to mention which mitigation measures are to be taken, if there is any impact on these three fishing activities, which in our view are prawn fishing, line fishing, shrimp fishing and the artisanal fishermen. It is necessary to take into account that each one of these groups functions according to the seasons and the economic	We agree with your approach. This is still a preliminary study as the detailed or specialist studies are still being prepared. The identification of the impacts and the respective mitigation measures is ongoing. In November of this year we will come back to present the Environmental Impact Study and the results of the environmental impact assessment.

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value of each one of their catch. And diverting someone from a fishing process, or prawns or deep-sea crustaceans, does not have the same impact as diverting someone who is practising beach seine to catch fish, but from a socio-economic point of view it may be very important for their families.	
Environmental Impact Study –Socio-economic study	
Joaquim Russo de Sá, Ministry of Fisheries Regarding the economic environment the observations are related to the impacts on the activity of the individual artisanal fishermen, the semi-industrial trawling prawn fishers using ice. In fact, if the fisheries specialists study the situation in more detail, they will see that there is an area exclusively for semi-industrial prawn fishing, nobody else can fish there, in the Machanga and Chiloane area.	Due to depth constraints, because the platform is unable to reach very shallow waters, in fact no wells can be drilled in shallow waters. We will take care to avoid that the fishermen are affected. There is an integrated communication system in which the fishermen know always where the vessel is, we have a liaison officer for fishing, there will be support vessels around the drilling platform that will emit signals to prevent the fishing boats from getting too near the platform for security reasons. There are various mechanisms that will be used to minimize the impacts on the fishermen. For example, we are now monitoring the implementation of the Environmental Management Plan in the Rovuma Basin and we have an environmental field officer, based in Pemba, we have liaison officers for fishing, support vessels, liaison officers for the communities. Thus, for this project a detailed Communication Plan will be designed that will minimize the impact on fishermen.
Waste Management Plan	
Joaquim Russo de Sá, Ministry of Fisheries Regarding waste, it is important how the mitigation of the impacts of this waste is clarified, because we don't know if there might be problems with the fish products and, consequently, problems with public health due to some of this waste.	Regarding waste, we can't give many details because in this phase we are still making an assessment of the environmental impacts and the Waste Management Plan, which will indicate which waste will be discharged and to where it will be taken, has not yet been prepared. There are regulations stipulating what can be discharged into the sea and what can not, if the vessel will have a water treatment system and will only discharge the waste water after treatment, if the vessel will have a system to cut up certain waste as much as possible, which can then be discharged into the sea, what can be transported to the coast according to the availability of waste treatment and disposal facilities in Mozambique. Thus, all these issues will be taken into account and a Waste Management Plan will be prepared for the project.

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Rui Minir, IUCN I would like to know if there are no communities on the coastal area of the wells? And if there are communities, do they only carry out fishing activities or do they have other activities, as it is known that the majority of the population in Mozambique depends on agriculture? And if there is agriculture in this area, how will it be considered, since it was not mentioned as an aspect to be studied during the environmental study?	The main focus was on fishing activities, because this activity is performed on the coast and at sea and can be more affected by the project than activities such as agriculture. However, the socio-economic study includes all other types of socio-economic activities performed in the area, including agriculture. All these issues are being assessed and a socio-economic study is being done and the impacts of the project on these activities will also be assessed. We decided not to mention these activities here because in fact the main impact of the project will be on activities performed at sea or on the coast, such as tourism, recreational activities of the tourist enterprises and fishing. As already referred to several times, this is only a preliminary study as detailed or specialist studies are still being prepared. In November of this year we will come back to present the Environmental Impact Study and the results of the environmental impact assessment that still will be made. The whole socio-economic situation, such as the agricultural and employment issues in the districts covered by the project will be part of the socio-economic study.
Rui Minir, IUCN The whole infra-structure of the project mobilized on-site will have some direct impact on the communities living on the coast. Some people may abandon their activities in the expectation of getting a job and some income for their subsistence.	Regarding the impact of the project on the coast, an offshore exploration well will be drilled and the platforms will be there only for 40 to 45 days and possibly another 10 to 15 additional days for well testing. It is a very specialized technical job and if we look at what the local populations can offer in terms of employment there is very little availability for job creation on the platform. If in future a discovery is done and the project proceeds to the development phase, the petroleum production phase, then things change. An example of this is in England where there was a small fishing village, which is now a large petroleum industry town. But this is very far away and will only happen if petroleum or gas is discovered. There is a distinction between the minimization of impacts and social projects. Sasol prefers to separate these two issues. Sasol has already been in Mozambique for some years in the Pande and Temane areas and we are doing social investment in these areas, totally independent from any impact mitigation. It is only a question of social responsibility. We have a systematized annual

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	social investment programme, independent of the exploitation and exploration programmes. However, for the M-10 and Sofala block areas social investment is not foreseen. But because we also know that expectations are very high when we arrive at a certain zone, we will intervene because there are situations in which we can identify immediate needs, which we will try to respond to but there will not be a vast social investment programme associated with this kind of activities because it is an activity performed in a very short period of time and we consider social investment for long-term development activities. And if we don't discover gas on these sites we will not stay for a long time.

Table C. Meeting in Govuro (26 August 2010)

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General aspects	
Bernardo Mandava, President of the Machanga Fishermen Association In this preliminary study phase we don't have yet big issues to discuss because we don't know yet if the project will go ahead or not. This discussion will be held in a later phase when you will present the results of the Environmental Impact Study, after its approval by MICOA.	Though the study is still in a preliminary phase, we still have the opportunity to discuss the issues at the level at which we are. We will not come back here after MICOA has approved the project but before the approval to present the results of the study. After this meeting we will send the preliminary report to MICOA. After that we will start the studies and prepare another report, which will contain the assessment of the impacts of the project and the conclusions of the study. However, before we send the other report to MICOA for approval, we will come back here to present it and once more collect your comments. After that we will introduce all your comments into this final report, which is then sent to MICOA. Thus, it is not the contrary, we will not wait until MICOA approves the report and then come and discuss it.
Luís dos Santos Namanha, Director of the Bazaruto Archipelago National Park In the first place I would like to thank Sasol for the effort it is making in Mozambique in	Thank you for your comment. We thank you on behalf of Sasol and we believe in your receptivity to continue this collaboration and to continue the execution of your projects, always with the concern to preserve the

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the division of non-renewable resources that is the result of renewable resources.	environment of the area where they operate and of the surrounding area.
Luís dos Santos Namanha, Director of the Bazaruto Archipelago National Park Another aspect is the intervention and role of the consulting company, Impacto, which is solid and transparent in the way it presented its report, having already mentioned very important aspects such as the impacts anticipated during the drilling activities.	Thank you for your comment. We thank you on behalf of Impacto.
Luís dos Santos Namanha, Director of the Bazaruto Archipelago National Park As an environmentalist, I note that many projects have been executed but leaving aside a very important aspect, which is the study, analysis and future of the biodiversity as an important element for the next generation. In order that a project proceeds, it needs a healthy environment. In the ongoing activities, one of the aspects that should be studied with greater emphasis is the biodiversity and that it is respected by the population itself and by the Government. The protection of the Bazaruto Park should be done through the continuous mitigation of its biodiversity. We are not concerned about the support Sasol will give in terms of social projects but that it will sustain the renewal and protection of biodiversity. Sasol is one of the partners that are giving support to the Park. I suggest strengthening this support because by supporting the park we are protecting the life of the population and also the hydrocarbons resulting from the biodiversity, from natural decomposition. The Park plays an important role in the mitigation of the effects of tomorrow.	Comment registered.
Luís dos Santos Namanha, Director of the Bazaruto Archipelago National Park I would like to thank Impacto's approach and say that this study will determine the intervention that will be made by Sasol in favour of the country's development. I know that Sasol has been taking actions in the social, educational, agricultural and other	Comment registered.

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areas.	
Joaquim José Mandima, Advisor to the Govuro Fishermen Association, Nova Mambone According to the presentation there are five blocks, namely, Petronas, 16, 19, M-10 and Sofala. We would like to know which are the blocks where drilling will be done? In which of the blocks will the first drilling be carried out?	This Environmental Impact Study only focuses on the M-10 block and the Sofala block. For the block 16 and 19 licence the Environmental Impact Study was concluded in 2007 and is valid until the end of Sasol's licence, which expires in 2013. Because Sasol is now operator under the M-10 and Sofala block licences we need a new Environmental Impact Study for drilling exploration wells under the M-10 and Sofala licences. Under the licence of this contract now signed by Sasol with the Government, Sasol is obliged to drill a well in the Sofala block and a well in the M-10 block before the end of the second exploration phase. At this moment, this licence expires in 2012. In the 16 and 19 blocks Sasol does not have any commitment to execute new well drillings. However, if Sasol finds a new prospect or a new site in which there are indications of the possible existence of gas we will propose the drilling of new exploration wells to the Government but before any new well is drilled, information will be given and consultations and discussions will be held about the new wells. At this moment, Sasol is reviewing the results of the seismic survey done by the Bang company in 2007 in the M-10 and Sofala areas. Sasol has identified some areas in which it may want to drill but at this moment the risks are still very high. These are not technical risks for the project but risks of finding gas or not. Thus, Sasol is looking for other areas within the M-10 and Sofala blocks where it can drill and when it has a more concrete idea about the potential of the whole area within the M-10 and Sofala licences, an assessment of all possibilities will be made and drilling will be done according to the best option of this assessment, i.e., on the site with the best conditions.
Joaquim José Mandima, Advisor to the Govuro Fishermen Association, Nova Mambone	In 2008/2009, Sasol drilled exploration wells in the 16 and 19 blocks, called "Ndjka 1" and "Ndjka 2". In both wells Sasol found gas. However, at this moment the amount of gas

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I participated in the previous meetings in Inhassoro about the 16 and 19 blocks and I know that drilling was done. However, I don't know the results of this drilling.	found in each one of the wells is not sufficient to pay for the installation of infra-structure on the well site and the transport of gas to the coast. Sasol has declared the area around the drilling site an area of discovery, which gives it more time to assess the economic viability of exploitation. Sasol is looking for opportunities to reduce the cost of the infra-structure or to increase the amount of gas found, which may justify its production. These studies are still being done in combination with what will be discovered in the M-10 and Sofala blocks. Thus, Sasol intends to assess if all the gas found in the 16 and 19 blocks and in the M-10 and Sofala blocks is economically viable. Sasol is very satisfied for having found gas in this area, which shows that there is gas offshore along the Mozambican coast but before proceeding with the production of gas, it should know exactly which quantity of gas exists.
Communication Plan	
Fernando Machoe, Machanga District Services of Economic Activities More than 50% of the population of Machanga depends on fishing for their subsistence. It was said that at the beginning of the drilling activities some people would be involved to communicate with the communities. But I suggest that the process be done the other way round, because from the experience we had with the seismic survey there were many abstract comments regarding the withdrawal of fish. Thus I request that before or immediately after the approval of the report, and before the beginning of the activities, the communities are informed through created groups or via pamphlets, because as we know the population does not have a high level of schooling and abstract comments may arise afterwards and cause conflicts.	There is a difference between how the seismic survey is done and how an exploration well is drilled. The seismic survey covers a very large area within the block. Because of this, in each phase the vessel is at the same spot for a very short period of time, moving from one place to another and emitting compressed air, which is suddenly liberated. Because of this, the fish occurring in the area flees from the seismic survey vessel because they hear this sound first very low and as the vessel approaches the noise increases and the fish flees, turns round and then reappears behind the vessel. It does not disappear from the area. When drilling wells, the platform remains at a fixed point and produces noise when drilling. This sound has the same level as that of a large ship that is approaching the Port of Beira and is fixed at a single point. The fish gets used to this noise because it is constant, as the bit is always drilling the hole and remains near the platform, they don't flee.

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	Normally the impacts of seismic surveys on fishing are bigger because the fishermen are prevented from fishing in an area due to the movement of the vessel but the platform is fixed and the fishermen can fish as they wish, outside the exclusion zone of a minimum of 500 metres for the security of the fishermen and their fishing activities. The environmental study that is presented here today refers to the drilling project and does not include the seismic survey. The environmental study for the seismic component has already been done and is a separate project.
	Regarding communication, the communication teams will be in the field before the arrival of the platform. We will not wait for the arrival of the platform to transmit information to the local population. We don't know yet how the Communication Plan will be designed for this specific project but we normally have a base and a liaison officer for the communities in each affected area. There will also be a liaison officer for fishing who will be based aboard the support vessel that will circulate around the platform. Thus, there is a very extensive mechanism to try to communicate, but always beforehand, about the position of the platform. In the case of the seismic survey the communication has different phases due to the movement of the seismic vessel to guarantee that the fishermen know where the exploration is being done. But in the case of drilling, information is normally transmitted before the arrival of the platform, its coordinates are given, the number of days during which it will remain at the same spot and the exclusion zone. Thus, there is a small difference between the implementation of the communication for seismic survey and for the drilling of exploration wells. But we will guarantee that the information will reach the communities before the start of the project.
Luís dos Santos Namanha, Director of the Bazaruto Archipelago National Park	Comment registered. See response above.

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We expect that in this second phase of the exploration the communication will be wider.	
Victor José António, Provincial Directorate of Mineral Resources and Energy In the southern part of Sofala Province there is the Buzi Hydrocarbon company that will do hydrocarbon exploration on land. Now we also have Sasol doing exploration in the same offshore area and we have two common elements, namely the community and the coastal area. We know that they are different companies but I would like to see coordination in the preparation of communication and compensation plans for the activities of the land and offshore companies, because in subsequent phases in which there was a single company there were complications with the communities. Thus, if the two companies have different communication and compensation plans, the situation will become much more complicated.	Suggestion accepted and registered.
Afonsina Fernandes, Provincial Directorate for the Coordination of Environmental Affairs I suggest that the Communication Plan should not only cover the implementation period of the activity but also the period before implementation to allow that the communities can understand what will occur and what is occurring.	Normally, at least a month before the start of the operations Sasol starts the communication and information process for the communities and fishing associations, paying field visits with explanatory pamphlets in local languages, with a photograph of the platform, explaining about the platform, the support vessel, the exclusion zone, etc. Communication is one of Sasol's basic concerns. In addition to the pamphlets Sasol also works with the community radios and with the provincial broadcasting station of the respective provinces, the Provincial Broadcasting Station of Inhambane and the Provincial Station of Sofala, including Radio Maria. However, because of the compensation team, this communication will continue for another month after the conclusion of the project, so that in the case of any claim we are sure that the issue is closed.
	According to Sasol's experience with previous projects the Communication Plan not only applies to the drilling period but

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	starts before the beginning and continues after of conclusion of the project. The drilling sites have not yet been selected. The communication programme can only start when we know the drilling sites because the communication teams can then provide exact information about the vessel's position. The communication plan will occur before, during and after the drilling activities but at this moment we cannot do much more because the drilling sites have not yet been defined. In exploration it is not possible to decide today that drilling will be done tomorrow. A lot of time is necessary to order the equipment, request the platform and bring it here. Thus, when we identify the site where we want to drill we will need about nine months to order the equipment and do a preliminary exploration in the area. Thus, all this time allows the implementation of communication.
Afonsina Fernandes, Provincial Directorate for the Coordination of Environmental Affairs We are in the EPDA preparation phase and the EPDA will reflect what will be the Environmental Impact Study. Thus, all important aspects should be mentioned in the EPDA to be reflected in the EIA. Thus, the Communication Plan should be designed in this phase so that it can be reflected in the EIA.	We agree with your comment. The only thing that cannot be dealt with is when the Communication Plan will be implemented, and also very detailed aspects of the contents of the plan, though in this phase it is possible to lay down already the general principles.
Eduardo Vicente, Provincial Directorate of Fisheries I would like to insist again on the issue of communication, taking as example the 16 and 19 blocks. Sasol knows that there were claims in 2007 for fictitious compensations because no preliminary and coordinated work was done due to lack of communication. At the time, when things became very complicated, we had to suggest how they should be dealt with. In fact, communication is the key factor	Thank you very much. Your suggestions and recommendations are noted and will be considered. A list of consultants and studies that will be done was presented but the consultants will not work without the institutions, as it is through these that we will collect the information to be included into the report. As for example Mr. Atanásio Brito, who works for fisheries, is our fisheries specialist and has worked a lot in the Sofala Bank area and has a lot of information about the area. Thus, we bring together consultants

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of this work. If we fail to communicate we are liable to compensate people. The communities and the districts should be involved to avoid opportunism and compensation claims. The involvement of all these should be done well before the start of the studies and of the project, as is the case of the IDPPE, which deals with the fishermen and which should be informed to start doing its work. At district level we have the District Services of Economic Activities, of which fisheries is part, as well as the small units which are the community fishing centres and the fishing associations. The Census taken by the IDPPE should be used as a basis since it has data about the number of fishermen and fishing boats existing in each district, though they are a little outdated because fishermen are migratory. The Census has data at district, provincial and national level.	who will do the work but they get information from the various institutions at central, provincial, district and local level. The involvement of the institutions is done at several levels, through the public consultation meetings and through direct contacts carried out by specialists who are working in the field.
Manuel Castigo, Secretary of the Govuro Fishermen Association I thank the Director of Fisheries for his intervention because he was able to transmit our concerns. As fisherman I declare and testify that in this area some boats were lost because they went to the Platform to receive compensation. Machanga and Nova Mambone have accumulated experience in the area of communication and compensation.	Comment registered.
Public Participation Process	
Afonsina Fernandes, Provincial Directorate for the Coordination of Environmental Affairs I suggest that in the next public consultation the DPCA is involved to send the report to some institutions existing in Inhambane Province so that they can give contributions about the study area. The Centre for Sustainable Development in Xai-Xai, whose field of activity is the entire coastal area from the Rovuma to Maputo, should also be involved.	The Centre for Sustainable Development was invited to participate in the meeting in Maputo. It was not possible to send the documents in advance to the key institutions as there was a delay in the submission of the Executive Summaries and to guarantee their delivery they will be sent to the provincial directorates and district administrations after the meeting; we brought a few copies to this meeting. They will be handed over to a few key institutions. We will also reserve a two-week period so that comments to the report can be made. In future we will improve coordination.

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Afonsina Fernandes, Provincial Directorate for the Coordination of Environmental Affairs I suggest that before the meetings there is coordination with the DPCA regarding the identification of the interested and affected parties of the project, since our Directorate can give its contribution with a few institutions that work directly or indirectly with us in the assessment and review of studies so that they will also participate in the meetings and in the public consultation process.	Comment registered and will be taken into consideration.
Environmental Impact Study	
Eduardo Vicente, Provincial Directorate of Fisheries It is important to involve all institutions that are related to the project during the environmental study. In the case of fisheries the Fisheries Research Institute, the Small-Scale Fisheries Development Institute (IDPPE), INAQUA, the aquaculture companies, and others, should be involved.	Thank you for the suggestion.
Jamilo Amade, Small-Scale Fisheries Development Institute I have a question regarding what was said about the distance and depth of the M-10 block, because it was said that there are no artisanal fishermen in this block. Currently, the Ministry of Fisheries is encouraging the fishermen to fish offshore. What we have observed is that of late many artisanal fishermen have a tendency to fish further away until a depth of 20 metres and they have acquired boats of greater capacity.	When it was said that there is nobody in the M-10 block, this referred to the existence of inhabited islands and the absence of tourism. It was not said that there were no fishermen, since the map we showed indicates the existence in the area of a zone of industrial and semi-industrial prawn fishing, deep-sea prawn fishing in very deep zones and an industrial prawn fishing zone. Thus, we are aware that there are different types of artisanal fishing (line fishing, with the use of ice, etc.) in our study area. The measures will be taken carefully, so that the impacts are minimized, so as to avoid affecting the fishermen's activities in this area. It is therefore important to know what exists and which activities are being carried out in our study area, precisely so that we can know how they can be affected and how we can reduce the impact on these activities. From our preliminary studies we already know that there are many fishermen in the area and that Búzi and Machanga have the largest number of fishing camps.

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Jamilo Amade, Small-Scale Fisheries Development Institute I have a question about the distance and depth of the drilling sites. In the previous exploration, some fishermen sailed to very distant points where they knew that they would find the vessel, reaching depths of 20 metres.	For the Sofala block the minimum distance to the coast is 1 km and for the M-10 block the minimum distance to the coast is 12 km, reaching depths of 20 to 30 metres. Thus, there are certainly fishermen in these areas.

Table A. Meeting in Beira (23 August 2010)

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General aspects	
Jeque Marcos Augusto Sitole, Djalani Fishing Community Council What will the distance probably be between the Sofala coastline and the possible drilling sites, since these have not yet been identified?	The exact position of the drilling sites is not yet known. Four potential sites were selected (two in each Block) specifically to make an assessment of the dispersion models. They are not at all final sites, they were merely selected to include different types of environments in the context of the whole concession area. So, the position of each drilling site is not exactly known.
Nelson Velho, Cornelder On page 5 of the Non-Technical Summary it says “to confirm commercial quantities of renewable hydrocarbon resources”, but I don’t think that the use of the term “renewable” is adequate because hydrocarbons are not renewable.	Thank you. This aspect will be taken into account and revised.
António Mutondo, President of the Dondo District Fishing Community Council I would be grateful if during the exploration no fish is transported to another country, that you will limit yourself to what was granted, namely gas exploration.	Thank you. Comment registered.
Mateus Ribáue, Provincial Directorate of Tourism Is the offshore well drilling technique the same as the technique used on land?	The offshore drilling technique is almost the same as the technique used on land.
Mateus Ribáue, Provincial Directorate of Tourism In Sofala several studies were done regarding hydrocarbon exploration in Machanga, Muanza, Savane, Inhaminga, Cheringoma	The only justification that exists for the fact that the communities and institutions have not been informed about the existence or not of hydrocarbons in commercial quantities is that no hydrocarbons were found in these areas. In principle each one of the proponents

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and the Zambezi Delta but until now we don't know the results, if there are hydrocarbons or not and which are the commercial quantities. I suggest that in the same way as the public consultation is done, the report of the exploration carried out in these areas should also be presented and made known to the local community and the provincial and district governments. It should not be a secret because there is no official information whatsoever yet. We know that the studies were done by Impacto.	is responsible for communicating this information but this was possibly not done because no hydrocarbons were found. When Sasol last year found gas the company announced it publicly and so did Anadarko. However, we agree that the information should be given. The studies done in the areas referred to were not done by Sasol but by other companies.
Nelson Velho, Cornelder I would like to know which are the consequences of the withdrawal of a layer of gas or petroleum from the subsoil? The strata will be affected by the extraction of gas?	From the worldwide experience of similar activities there is no record or information of any area that has collapsed due to the extraction of gas or petroleum. And it is not expected that the extraction of gas in Mozambique will cause the collapse of earth.
Mateus Ribáue, Provincial Directorate of Tourism It was said that Sasol is interested in gas, but if it happens to discover petroleum in the same area, what will its attitude be?	The petroleum development process is different from gas. Petroleum and gas were formed millions of years ago by plant and animal matter. Gas and petroleum are formed in different temperature and pressure conditions. Sometimes both can be found, as is the case of Anadarko in the north. We hope to find gas as in Temane and Pande. Different processes will be used if we happen to find petroleum instead of gas and there will be different plans, depending on the quantities that are found. We cannot be specific in terms of the procedures to be followed, as these depend on the quantities and viability of the product found. It will also depend on the price on the international market, which changes constantly.
Jeque Marcos Augusto Sitole, Djalani Fishing Community Council What is the impact of petroleum drilling on existing submarine fibre-optic cables?	Some of the areas in which we did environmental impact studies for drilling projects were traversed by a fibre-optic cable and there were no incidents. But everything already indicates that the submarine fibre-optic cable does not traverse the Sasol concession areas (M-10 and Sofala blocks, respectively). Anyhow, before the drilling starts, there will be a machine operated by remote control, which will check the whole seabed in the area to see if there are obstacles. On the basis of this it can be determined if there is a fibre-optic cable or not, or any other obstruction. Before the drilling there is a pre-

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	assessment of the drilling site.
Dispersion of drill cuttings	
Jeque Marcos Augusto Sitole, Djalani Fishing Community Council It was said that the drilling will result in the production of drill cuttings that may accidentally be dispersed into the sea. This will have a negative impact on the coastal area, mainly for fishermen, because it will scare away the fish along the coast and there will therefore be a serious fishing crisis for some time. Which mechanism is foreseen to control the dispersion of cuttings?	The vessel has a system for the separation of solids. The process will involve the use of muds that have a series of functions in the course of the drilling process, for example to help the bit to go down and regulate the pressure, and as the bit will perforate below it will bring with it what are called cuttings or pieces of rock. These cuttings are not harmful, they come from the soil, from the environment. The only problem is that the cuttings may contain some traces, very small quantities of mud. But Sasol intends to use water-based muds and synthetic, non-oily muds. Synthetic or mineral muds will be used that are not harmful to the environment. A Waste Management Plan will be prepared that will determine what will be done with the cuttings.
Disposition and management of drill cuttings	
António Mutondo, President of the Dondo District Fishing Community Council Where will the drill cuttings be deposited during the activities?	A Waste Management Plan will be prepared that will determine what will be done with the cuttings. At this moment cutting dispersion models are being prepared that will help to determine the best disposal options.
Impacts of the drilling activities on the marine fauna	
António Mutondo, President of the Dondo District Fishing Community Council Are the cuttings not going to contaminate prawns and fish? And will this not cause a serious crisis in fishing?	We are in a pre-viability phase and do not yet bring the conclusions and impact analysis. The impact assessment is still to be made and the results will be presented when we will present the Environmental Impact Study in November. Thus, all impacts of the drilling project on prawns, fish, turtles and whales, on all activities, animals and plants will be assessed and presented in November. It has not yet been determined exactly if the drilling project will affect the fish.
Mateus Ribáue, Provincial Directorate of Tourism If by chance a hydrocarbon leak or spill accident occurs in the area, there is a concern that it will affect the existing marine fauna, whales and dugongs in this area, as well as the Bazaruto Archipelago National Park, also	The Bazaruto Archipelago National Park is situated at about 50 km and 100 km from the Sasol concession areas. Sasol has already carried out drilling activities much nearer the Bazaruto Archipelago and without any incident. We normally take the objective of the creation of the there existing Park into account, and which are its sensitivities. An

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situated in the same area and created for the protection of dugongs.	analysis is made of each sensitive area existing in the proximity of the project. For the time being, the only possibility of the project affecting the Park, in this preliminary phase, is the occurrence of some hydrocarbon spill incident, which is not expected to happen. All these aspects will be taken into account in the study and we therefore decided to include the Bazaruto Park in our area of indirect influence. The decision to have a large strip of coastal area for our studies is because we want to be sure that we will include all sensibilities existing in the area.
Impacts of the drilling activities on fishing	
António Mutondo, President of the Dondo District Fishing Community Council Will the fishermen be impeded to fish or not during the forty-five drilling days?	An exclusion strip of at least 500 metres will be established around the platform, during the about 45 days of drilling, to avoid for example collisions and other impacts and to try to avoid that these boats get too near the platform. However, the fishermen will be able to continue fishing in the remainder of the area outside the 500-metre strip. There will be a good communication system. The fishermen will be informed about the drilling sites and where the platform will be situated. Studies are being done and as much information as possible about the activities occurring in this area is being collected, on the coast and verify how these can be affected so that we can reduce impacts on these activities as much as possible. Sasol has already experience with Communication Plans. One of our biggest concerns, when operating on any project in or outside Mozambique is related to the relations with the communities. Sasol's previous experience in an extremely sensitive zone was in the Bazaruto National Park. What we do to ensure that all communities are de facto involved and receive prior information. We establish right at the beginning a communication office where we guarantee that all interested or affected people are part of this circle of communication and to this end we have a liaison officer for the relations with the communities and the fishermen. During

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	drilling we will have a vessel in the 500-metre exclusion zone around the platform that will supervise this exclusion zone. In this vessel the officer liaison for the fishermen or the communities will be stationed and we guarantee that he/she will be a person who is able to communicate in the local languages to guarantee that the communication is efficient and effective. Thus, we will be sure that the people are approached by this vessel calling attention to avoid coming near the platform communicating in the local language and that the people understand de facto what is going on.
Waste Management Plan	
	We will also have an office in Beira because our logistics will be done from Beira and we will have someone on land where everybody will have access to the daily reports of our operations. Impacto has accumulated experience in the preparation and implementation of communication plans, both in the seismic survey phase and in the drilling phase. We normally identify all fishing communities, villages and centres that will be affected, we create a field team to provide daily information to these fishermen about the position of the exploration vessel, in addition to the presence of a support vessel. We cannot present conclusions about the impact of the project on fishing, nor an assessment of the impacts in this phase because we are in a preliminary phase. We are collecting information of the area and are still making an assessment of the environmental impacts. We will present the results of these impacts in November when we come back. We are, for example, assessing if the noise will cause impacts on the fish, if the fish will flee or come closer, if the fish will ingest waste and have some problem, if the fact of having a 500-metre strip around the vessel will affect fishing or not. Means will be created to allow the provision of regular information to all artisanal, industrial

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	and semi-industrial fishermen about the position of the vessel so as to minimize the impacts. All these impacts are still being studied.
Nelson Velho, Cornelder On page 6 of the Non-Technical Summary it says that two types of muds will be used, the synthetic and the water-based type. Regarding the synthetic mud, it was said that waste management of this mud will be done, but what is noted is that this waste is sometimes sent to private entities and is not properly stored. I would like to know if, when this waste management is done, there are plans for its recycling or its disposal in other sites outside Mozambique, because as far as I know we don't have capacity at this moment to store waste nor to recycle it.	We are aware that Mozambique does not have waste management facilities. One of the paragraphs of the Non-Technical Summary says that "the waste will be transported to the coast for final disposal". This paragraph will be deleted, because in fact it is still necessary to assess how all waste should be treated taking into account that Mozambique does not have these resources. Thus, the Waste Management Plan will determine how the process will be done. There are for example certain types of waste that can be discharged into the sea, such as the ablution effluents and others that can be treated by an onboard system, there are wastes that can be incinerated, and others can be transported to other countries or taken to our coast. All these possibilities will be assessed during the preparation of the Waste Management Plan.
Spills Contingency Plan	
Nelson Velho, Cornelder Has a contingency plan already been defined for cases of leaks? This plan should not only be defined theoretically, but also in practical terms and various entities should be involved in this contingency plan. I say this because in general contingency and emergency plans are defined but when a disaster occurs their implementation becomes a bit difficult because most of the plans have a theoretical basis and sometimes the contact numbers and spill containment actions are not viable. Beira City does not have any spill containment mechanism.	There is no contingency plan yet for petroleum spills. Plans have been prepared for previous projects and a dispersion model is being prepared, which in previous studies was done for a fourteen-day dispersion period. This period is now being extended to two months to guarantee that all impacts and areas that may be affected are properly studied. Thus, on this basis a specific plan will be designed for this project and the key institutions will be contacted in order that the Environmental Management Plan is feasible, and not only theoretical. Sasol is in the gas area and not in the petroleum area. Sasol's offshore exploration is to find gas and not petroleum. We will however consider all these hypotheses. For all diesel or mud spill levels there will be a written plan and all platform crew will have to read and know what is stipulated in this plan and should sign that they know what the plan says and they must comply to the letter with what is stipulated by the plan.

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	Depending on the type of spill and if the spill is large the number of people involved will be larger, including the Port of Beira personnel, and if there is a justified need people at international level should also be involved. All this will be considered at the beginning and well before the possible occurrence of a spill and measures will be taken so that, if it happens, there can be an immediate response. The most important aspect however is that there will be control measures in the final document to avoid the occurrence of spills.
Nelson Velho, Cornelder It is important that not only preventive measures are taken regarding possible spills or that the contingency plan is known by the people who are onboard or at local level, in the provinces or in the port but also that Sasol has containment means for possible spills or leaks. Taking as an example the spill that occurred a few months ago in the USA, everything was functioning perfectly well, all the plans had been prepared but there was a petroleum leak. It is therefore important to have containment means at provincial level because we don't have any containment means. It is important to have prevention mechanisms and we all know that they exist but it is much more important to have containment means in the case of a possible leak.	The issue of spills does not apply to this project because Sasol intends to explore gas and not petroleum. However, a detailed contingency plan will be prepared and will include a full implementation structure. We agree with the suggestion that not only those who are onboard the platform but also the institutions (Port, Maritime Administration, Fisheries, etc.) that by force of circumstance will be involved should participate in the harmonization of this plan and know it and be trained for the implementation of the plan. Because, if de facto something happens these institutions should be in the field.
Nelson Velho, Cornelder These projects give rise to doubts and distrust regarding how the Contingency Plan will be implemented or managed. It would therefore be good to create a mixed commission of technicians and others to visit the platform and check that everything what was mentioned is being implemented correctly in agreement with the provisions of this plan.	Thank you for the recommendation and we agree that the preparation and implementation of the contingency plan should be quite participatory and the institutions should be adequately involved. An implementation exercise of this plan can even be planned.
Glória Naene, National Institute of Disaster Management I would like to know which involvement is foreseen of the communities that may be	Sasol foresees the involvement of the various institutions in the preparation of the contingency plan, including a direct intervention to assess the potential in terms of available and lacking equipment and what

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directly or indirectly affected by said possible spills in the preparation and implementation of the Contingency Plan? I would like to manifest our interest in being allowed to participate in the preparation or implementation of the Contingency Plan.	should be brought and the priorities to be defined in the plan.
Water quality	
Murate, Provincial Directorate of Health, Environmental Health Department On page 91 of the EPDA report reference is made to the impact on water but it does not say if this concerns seawater or potable water.	When referring to the impact on water we mean seawater, as we refer to all discharges of all activities resulting from the vessel's operation (deck water, ballast water, ablution water, potential discharges of waste that is allowed to be cast into the sea) and we will assess what impacts these discharges may cause on the quality of the seawater, for example if there will be an increase of turbidity.
Socio-economic issues	
Murate, Provincial Directorate of Health, Environmental Health Department The Non-Technical Summary refers to all aspects except human health. It refers to the environment, fishing, but not to the surrounding population.	The socio-economic studies will also include health. For example, if there is a spill, how it will affect the fish and how this fish may affect the health of the population.
Social projects	
Nelson Velho, Cornelder We all know that when there is economic investment in a certain area the Government requests the investor company to make a contribution to the local population or community living in this area. In indirect terms we know that there will be a contribution in terms of employment and the logistics that will be done from the Port of Beira. In direct terms we would like to know which contribution Sasol will make to Beira City or Sofala Province.	Sasol has a sector in its strategy dealing with its social responsibility. In principle, when Sasol entered the Mozambican market, still in the project phase, it did some work in the social area in Sofala Province, specifically in Machanga District. At this moment we are concentrated on the operational areas, with greater emphasis on the Pande and Temane areas, in Inhassoro and Govuro Districts. I cannot say if in this phase of the project something will be done in social terms. We are in the exploratory phase and if gas is discovered in commercial quantities this area will become an operational area and we will have activities materialising our social responsibility.
Availability of information	
Jeque Marcos Augusto Sitole, Djalani Fishing Community Council	We will take this aspect into account in the next phases. However, the first document sent to the public was the Discussion

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The distribution of the EPDA reports should not be limited to the provincial directorates, but should also cover the community structures, because we cannot leave the fishing areas and go to the institutions to consult the document. For the next meetings we would like to ask you to have reports available for distribution according to the number of participants.	Document and it was sent to everybody on the preliminary list of interested and affected parties. The Non-Technical Summary that was sent now, was also distributed to everybody on this list and to others subsequently identified. We regret the delay occurred in delivering the documents locally but the documents were sent to the districts to be handed over to the communities, not to everybody but to the representatives of the consultative councils, fishermen associations, etc. We will try to cover the largest possible number of people.
Communication Plan	
Arlindo Miguel Faustino, National Hydrographical and Navigation Institute (INAHINA) On the basis of your experience with other projects, which signalling and communication method with the boats will be used, since traffic in the Port of Beira is very heavy and many fishermen do not even have a radio to communicate? Perhaps the solution is to use light signals, which is the method used by us and the fishermen in our channels.	Regarding communication we will make use of the positive experience we already have from other projects. There is communication at the level of the navigation control institutions to allow information via radio, there is direct information to the fishing centres about the activity. Thus, a complete mechanism has been created to cover the boats that have radio communication as well as all the artisanal fishermen who do not have these instruments but who need to have this information. Before the arrival of the platform a notice to navigation will be sent to institutions such as INAHINA and INAMAR, which will transmit the information to other ships entering the area and subsequent information will also be given about where the platform is operating and the exclusion strip. Additionally, while the platform is operating at night it will be properly illuminated and it has various warning and prevention mechanisms to avoid collisions. Meanwhile, there will also be a support vessel, which will be circulating around the exclusion zone, also to inform about the distances regarding the approach of the exclusion zone, and the environmental officer for communication with the fishermen will inform even those fishermen who don't have a radio. Thus, the information will be given before the start of the drilling activities so that the fishermen will know where the platform is and that they should respect the 500-metre strip.

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António Mutondo, President of the Dondo District Fishing Community Council I suggest that the communications are done between 18 and 19 hours, because at this time the fishermen have already returned home. I also suggest to use Radio Mozambique as it is has a wider coverage. Communication should be done in three languages: Portuguese, Sena and Ndau.	Thank you. We will retain this information and take it into account during the preparation of the Communication Plan.

Table B. Meeting in Maputo (24 August 2010)

ISSUES	RESPONSES
General issues	
Jafar Ruby, National Hydrographical and Navigation Institute I think that on page 5 of the Non-Technical Summary, regarding the period of the occurrence of cyclones, there is a mistake because the April to November period is mentioned and in fact it is the contrary, it is from November to April.	Thank you for your observation, we will correct the data.
Rui Minir, IUCN I would like to know which is the area or radius of direct influence of the project?	Since we don't know yet the exact drilling sites, we consider the entire area within the blocks being the project's area of direct influence. The area of direct influence of block M-10 is 3400 km^2, which is the block M-10 concession area. In the case of the Sofala block it would be about 8614 km^2. Regarding the area of indirect influence we decided to select from each one of the limits of the concession to the coast and from the Bazaruto Park until the Zambezi River, so as to cover as much as possible the environmental and socio-economic conditions also existing on the coast.
Joaquim Russo de Sá, Ministry of Fisheries It is referred in the document that near the Sofala Bank the most abundant crustacean is prawns but in fact the Sofala Bank is the prawn bank.	Comment registered.
Drilling site	
Joaquim Russo de Sá, Ministry of Fisheries	Exploration is an industry in which we try to find new deposits of petroleum or gas. The success rate

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Though we know that previous and similar activities have already been carried out, our concern is related to the localization of the project and the Sofala Bank. It is important to take into account that more than 75% of the national fisheries production comes from the Sofala Bank. When we talk about the Sofala Bank we refer to the artisanal fisherman to deep-sea fishing, which is done at depths of more than 20 metres, through deep-sea crustacean fishing. If it would be possible to have an idea of the site of these drillings, even if at a reasonable scale, it would be important for those who are responsible for the management and distribution of the fishermen.	is normally 20 to 30%. This means that there is a 70 to 80% probability of not finding anything. Due to this it is very difficult to determine exactly the site where we should drill and we use the seismic survey to identify the best sites to drill. Hydrocarbons are found at different depths in the ground. For example, in Pande and Temane, on the coast, the depth of the hydrocarbons is about 1800 metres and in terms of seismic survey we are doing offshore exploration. We have identified some high-risk prospects at depths of about 1800 to 2000 metres. We have however also identified some greater-risk prospects at greater depths than these and we are now in the process of assessing the risk and the possibility of finding or not hydrocarbons and the cost of drilling these very deep wells. As soon as we have concluded this assessment we will make a classification of the risks and those sites with a larger probability to find gas or petroleum will be drilled. Drilling is also limited to the availability of a platform, in this case a "jack-up rig", in shallow waters until a depth of 15 metres. The platform is unable to reach these depths because the waters are very shallow. Meanwhile, this type of platform can also not operate at depths of more than 100 metres. And because we are still making this assessment and we have restrictions as to until where the platform can reach, we are still trying to find the best drilling sites. Thus, I don't think that we will be drilling in the area of shallow waters and we will also not drill in very deep waters. We have two potential sites in each one of the blocks that were only identified to do the cutting and hydrocarbon dispersion models. When we will know the exact sites we will prepare an Environmental Management Plan specific to the site and depth at which we will drill.
Number of wells to be drilled	
Joaquim Russo de Sá, Ministry of Fisheries In relation to the project we are concerned that we don't know how many wells will be drilled, because we want to avoid that in the high fishing season we would have to divert or to order the withdrawal of fishermen from the area where by coincidence there will be a well. Even with the situation you are expecting it is necessary to take into account that fishing is an activity in which what is not	The number of wells we want to drill will depend on the amount of petroleum or gas we find. However, we have to drill a well in the M-10 block and a well in the Sofala block in agreement with the contract signed with the National Petroleum Institute and the respective Ministry. The biggest part of the cost related to well drilling has to do with the process of bringing the platform to the drilling site and afterwards taking it out again. Thus, due to this it is more cost-effective and viable to drill the largest possible number of wells at one

ISSUES	RESPONSES
produced today, tomorrow will not be found on the same site.	go. But on the other hand the drilling of each well is very expensive and there are cost limits. Realistically we will drill a single well in each exploration period of the licence and possibly two wells at the most per licence for the exploration phase.
Drilling period	
Joaquim Russo de Sá, Ministry of Fisheries The other issue has to do with the duration of the project, with the part of the year. The season that is being suggested is from April to June and coincides with the fishing cycle season, mainly of prawns. The biggest prawn cycles are in April and May and it decreases abruptly, more than 50%, from June, July, August. If it would be possible to start in the second half of the winter, it would be excellent for fishing, but from what we read in the document received this does not seem to be very possible. So, this not being possible we suggest that drilling is done after June, to avoid a conflict with the high season. Though no longer today, prawn fishing is very important (accounting for 50% of the total value of exports of this country), at an important level in the country's economy, mainly regarding exports. The issue is that we can only limit ourselves to the document we have received and to the area shown on the map. If you say that you will not drill in the yellow-coloured area representing semi-industrial fishing it is excellent, but for us it is the whole area indicated and we are referring to this area. On the other hand, we understand all the reasons for which it is difficult to specify the period and the number of wells that will be drilled. However, the only issue we present here is to consider, if possible, to drill the wells after June, which is not yet the cyclone season, to allow that no disturbance occurs in the most productive fishing period.	For each drilling there is a period with which we have to be very careful, namely the cyclone period. For security and environmental reasons we don't want to have an offshore drilling platform operational in these conditions. On the other hand, it is very difficult to foresee when a drilling platform will be available, since we depend on the company that was previously using the platform somewhere else in the world. They first have to conclude the operations and only after this are available for the next client. For example, for blocks 16 and 19 we had planned everything to start drilling in June. The platform however only arrived in October. We will do what we can when we ask for the platform but a drilling platform costs about 170 thousand dollar per day, so that when the platform arrives we cannot simply let it wait. On page 6 of the Non-Technical Summary it says that "drilling is expected to be done after July". When April and June are mentioned, this refers to the occurrence of cyclones in the area. We would like to recall that fishing can continue to be done during the drilling period, except within the 500-metre strip around the platform. Outside this area fishing can be done at any time of the year.
Environmental Impact Study – Biophysical study	

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Joaquim Russo de Sá, Ministry of Fisheries In the ecology section the demersal species, which are caught through line fishing, are not referred to, contrary to the demersal prawn species that are caught by trawling. In the marine ecology section it is important that all species and all fishing activities targeting these species are referred to through the designations known by us. The document refers to two types of prawns, shallow water prawns and surface prawns. We do not know if these are two types of prawns or if it is the same with the same designation.	We thank you for the contribution and we will use it to improve the document. We will contact the fisheries specialist to pay attention to these issues when preparing his/her study.
Impact of the project on fishing	
Joaquim Russo de Sá, Ministry of Fisheries What is important to take into account in the coastal area, and which has not been done in the Non-Technical Summary, are semi-industrial prawn fishing with the use of ice, hand line fishing, which wasn't mentioned anywhere, and deepwater fishing of crustaceans. These are the three fishing areas for which we think that any intervention may become a problem and we are talking about a universe of about 25 to 30 semi-industrial boats, 10 industrial boats and over 5000 artisanal fishermen in the whole area.	The document distributed to the institutions is a small summarised document. The EPDA report gives more information about the various types of fishing practised in the area, but a study is being done especially focussing all types of fishing activities in the region and mentioned by you. We will guarantee that all these activities are included in the Environmental Impact Study and that the impacts of the project on these activities will be assessed.
Joaquim Russo de Sá, Ministry of Fisheries The fishing camps here referred to are those situated on land and will not have any problem. The problem is for those who will have to go out fishing at sea, where the drilling activities will take place.	Thank you. Comment registered.
Joaquim Russo de Sá, Ministry of Fisheries It is also important to mention which mitigation measures are to be taken, if there is any impact on these three fishing activities, which in our view are prawn fishing, line fishing, shrimp fishing and the artisanal fishermen. It is necessary to take into account that each one of these groups functions according to the seasons and the economic	We agree with your approach. This is still a preliminary study as the detailed or specialist studies are still being prepared. The identification of the impacts and the respective mitigation measures is ongoing. In November of this year we will come back to present the Environmental Impact Study and the results of the environmental impact assessment.

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value of each one of their catch. And diverting someone from a fishing process, or prawns or deep-sea crustaceans, does not have the same impact as diverting someone who is practising beach seine to catch fish, but from a socio-economic point of view it may be very important for their families.	
Environmental Impact Study –Socio-economic study	
Joaquim Russo de Sá, Ministry of Fisheries Regarding the economic environment the observations are related to the impacts on the activity of the individual artisanal fishermen, the semi-industrial trawling prawn fishers using ice. In fact, if the fisheries specialists study the situation in more detail, they will see that there is an area exclusively for semi-industrial prawn fishing, nobody else can fish there, in the Machanga and Chiloane area.	Due to depth constraints, because the platform is unable to reach very shallow waters, in fact no wells can be drilled in shallow waters. We will take care to avoid that the fishermen are affected. There is an integrated communication system in which the fishermen know always where the vessel is, we have a liaison officer for fishing, there will be support vessels around the drilling platform that will emit signals to prevent the fishing boats from getting too near the platform for security reasons. There are various mechanisms that will be used to minimize the impacts on the fishermen. For example, we are now monitoring the implementation of the Environmental Management Plan in the Rovuma Basin and we have an environmental field officer, based in Pemba, we have liaison officers for fishing, support vessels, liaison officers for the communities. Thus, for this project a detailed Communication Plan will be designed that will minimize the impact on fishermen.
Waste Management Plan	
Joaquim Russo de Sá, Ministry of Fisheries Regarding waste, it is important how the mitigation of the impacts of this waste is clarified, because we don't know if there might be problems with the fish products and, consequently, problems with public health due to some of this waste.	Regarding waste, we can't give many details because in this phase we are still making an assessment of the environmental impacts and the Waste Management Plan, which will indicate which waste will be discharged and to where it will be taken, has not yet been prepared. There are regulations stipulating what can be discharged into the sea and what can not, if the vessel will have a water treatment system and will only discharge the waste water after treatment, if the vessel will have a system to cut up certain waste as much as possible, which can then be discharged into the sea, what can be transported to the coast according to the availability of waste treatment and disposal facilities in Mozambique. Thus, all these issues will be taken into account and a Waste Management Plan will be prepared for the project.

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Rui Minir, IUCN I would like to know if there are no communities on the coastal area of the wells? And if there are communities, do they only carry out fishing activities or do they have other activities, as it is known that the majority of the population in Mozambique depends on agriculture? And if there is agriculture in this area, how will it be considered, since it was not mentioned as an aspect to be studied during the environmental study?	The main focus was on fishing activities, because this activity is performed on the coast and at sea and can be more affected by the project than activities such as agriculture. However, the socio-economic study includes all other types of socio-economic activities performed in the area, including agriculture. All these issues are being assessed and a socio-economic study is being done and the impacts of the project on these activities will also be assessed. We decided not to mention these activities here because in fact the main impact of the project will be on activities performed at sea or on the coast, such as tourism, recreational activities of the tourist enterprises and fishing. As already referred to several times, this is only a preliminary study as detailed or specialist studies are still being prepared. In November of this year we will come back to present the Environmental Impact Study and the results of the environmental impact assessment that still will be made. The whole socio-economic situation, such as the agricultural and employment issues in the districts covered by the project will be part of the socio-economic study.
Rui Minir, IUCN The whole infra-structure of the project mobilized on-site will have some direct impact on the communities living on the coast. Some people may abandon their activities in the expectation of getting a job and some income for their subsistence.	Regarding the impact of the project on the coast, an offshore exploration well will be drilled and the platforms will be there only for 40 to 45 days and possibly another 10 to 15 additional days for well testing. It is a very specialized technical job and if we look at what the local populations can offer in terms of employment there is very little availability for job creation on the platform. If in future a discovery is done and the project proceeds to the development phase, the petroleum production phase, then things change. An example of this is in England where there was a small fishing village, which is now a large petroleum industry town. But this is very far away and will only happen if petroleum or gas is discovered. There is a distinction between the minimization of impacts and social projects. Sasol prefers to separate these two issues. Sasol has already been in Mozambique for some years in the Pande and Temane areas and we are doing social investment in these areas, totally independent from any impact mitigation. It is only a question of social responsibility. We have a systematized annual

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	social investment programme, independent of the exploitation and exploration programmes. However, for the M-10 and Sofala block areas social investment is not foreseen. But because we also know that expectations are very high when we arrive at a certain zone, we will intervene because there are situations in which we can identify immediate needs, which we will try to respond to but there will not be a vast social investment programme associated with this kind of activities because it is an activity performed in a very short period of time and we consider social investment for long-term development activities. And if we don't discover gas on these sites we will not stay for a long time.

Table C. Meeting in Govuro (26 August 2010)

ISSUES	RESPONSES
General aspects	
Bernardo Mandava, President of the Machanga Fishermen Association In this preliminary study phase we don't have yet big issues to discuss because we don't know yet if the project will go ahead or not. This discussion will be held in a later phase when you will present the results of the Environmental Impact Study, after its approval by MICOA.	Though the study is still in a preliminary phase, we still have the opportunity to discuss the issues at the level at which we are. We will not come back here after MICOA has approved the project but before the approval to present the results of the study. After this meeting we will send the preliminary report to MICOA. After that we will start the studies and prepare another report, which will contain the assessment of the impacts of the project and the conclusions of the study. However, before we send the other report to MICOA for approval, we will come back here to present it and once more collect your comments. After that we will introduce all your comments into this final report, which is then sent to MICOA. Thus, it is not the contrary, we will not wait until MICOA approves the report and then come and discuss it.
Luís dos Santos Namanha, Director of the Bazaruto Archipelago National Park In the first place I would like to thank Sasol for the effort it is making in Mozambique in	Thank you for your comment. We thank you on behalf of Sasol and we believe in your receptivity to continue this collaboration and to continue the execution of your projects, always with the concern to preserve the

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the division of non-renewable resources that is the result of renewable resources.	environment of the area where they operate and of the surrounding area.
Luís dos Santos Namanha, Director of the Bazaruto Archipelago National Park Another aspect is the intervention and role of the consulting company, Impacto, which is solid and transparent in the way it presented its report, having already mentioned very important aspects such as the impacts anticipated during the drilling activities.	Thank you for your comment. We thank you on behalf of Impacto.
Luís dos Santos Namanha, Director of the Bazaruto Archipelago National Park As an environmentalist, I note that many projects have been executed but leaving aside a very important aspect, which is the study, analysis and future of the biodiversity as an important element for the next generation. In order that a project proceeds, it needs a healthy environment. In the ongoing activities, one of the aspects that should be studied with greater emphasis is the biodiversity and that it is respected by the population itself and by the Government. The protection of the Bazaruto Park should be done through the continuous mitigation of its biodiversity. We are not concerned about the support Sasol will give in terms of social projects but that it will sustain the renewal and protection of biodiversity. Sasol is one of the partners that are giving support to the Park. I suggest strengthening this support because by supporting the park we are protecting the life of the population and also the hydrocarbons resulting from the biodiversity, from natural decomposition. The Park plays an important role in the mitigation of the effects of tomorrow.	Comment registered.
Luís dos Santos Namanha, Director of the Bazaruto Archipelago National Park I would like to thank Impacto's approach and say that this study will determine the intervention that will be made by Sasol in favour of the country's development. I know that Sasol has been taking actions in the social, educational, agricultural and other	Comment registered.

ISSUES	RESPONSES
areas.	
Joaquim José Mandima, Advisor to the Govuro Fishermen Association, Nova Mambone According to the presentation there are five blocks, namely, Petronas, 16, 19, M-10 and Sofala. We would like to know which are the blocks where drilling will be done? In which of the blocks will the first drilling be carried out?	This Environmental Impact Study only focuses on the M-10 block and the Sofala block. For the block 16 and 19 licence the Environmental Impact Study was concluded in 2007 and is valid until the end of Sasol's licence, which expires in 2013. Because Sasol is now operator under the M-10 and Sofala block licences we need a new Environmental Impact Study for drilling exploration wells under the M-10 and Sofala licences. Under the licence of this contract now signed by Sasol with the Government, Sasol is obliged to drill a well in the Sofala block and a well in the M-10 block before the end of the second exploration phase. At this moment, this licence expires in 2012. In the 16 and 19 blocks Sasol does not have any commitment to execute new well drillings. However, if Sasol finds a new prospect or a new site in which there are indications of the possible existence of gas we will propose the drilling of new exploration wells to the Government but before any new well is drilled, information will be given and consultations and discussions will be held about the new wells. At this moment, Sasol is reviewing the results of the seismic survey done by the Bang company in 2007 in the M-10 and Sofala areas. Sasol has identified some areas in which it may want to drill but at this moment the risks are still very high. These are not technical risks for the project but risks of finding gas or not. Thus, Sasol is looking for other areas within the M-10 and Sofala blocks where it can drill and when it has a more concrete idea about the potential of the whole area within the M-10 and Sofala licences, an assessment of all possibilities will be made and drilling will be done according to the best option of this assessment, i.e., on the site with the best conditions.
Joaquim José Mandima, Advisor to the Govuro Fishermen Association, Nova Mambone	In 2008/2009, Sasol drilled exploration wells in the 16 and 19 blocks, called "Ndjka 1" and "Ndjka 2". In both wells Sasol found gas. However, at this moment the amount of gas

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I participated in the previous meetings in Inhassoro about the 16 and 19 blocks and I know that drilling was done. However, I don't know the results of this drilling.	found in each one of the wells is not sufficient to pay for the installation of infra-structure on the well site and the transport of gas to the coast. Sasol has declared the area around the drilling site an area of discovery, which gives it more time to assess the economic viability of exploitation. Sasol is looking for opportunities to reduce the cost of the infra-structure or to increase the amount of gas found, which may justify its production. These studies are still being done in combination with what will be discovered in the M-10 and Sofala blocks. Thus, Sasol intends to assess if all the gas found in the 16 and 19 blocks and in the M-10 and Sofala blocks is economically viable. Sasol is very satisfied for having found gas in this area, which shows that there is gas offshore along the Mozambican coast but before proceeding with the production of gas, it should know exactly which quantity of gas exists.
Communication Plan	
Fernando Machoe, Machanga District Services of Economic Activities More than 50% of the population of Machanga depends on fishing for their subsistence. It was said that at the beginning of the drilling activities some people would be involved to communicate with the communities. But I suggest that the process be done the other way round, because from the experience we had with the seismic survey there were many abstract comments regarding the withdrawal of fish. Thus I request that before or immediately after the approval of the report, and before the beginning of the activities, the communities are informed through created groups or via pamphlets, because as we know the population does not have a high level of schooling and abstract comments may arise afterwards and cause conflicts.	There is a difference between how the seismic survey is done and how an exploration well is drilled. The seismic survey covers a very large area within the block. Because of this, in each phase the vessel is at the same spot for a very short period of time, moving from one place to another and emitting compressed air, which is suddenly liberated. Because of this, the fish occurring in the area flees from the seismic survey vessel because they hear this sound first very low and as the vessel approaches the noise increases and the fish flees, turns round and then reappears behind the vessel. It does not disappear from the area. When drilling wells, the platform remains at a fixed point and produces noise when drilling. This sound has the same level as that of a large ship that is approaching the Port of Beira and is fixed at a single point. The fish gets used to this noise because it is constant, as the bit is always drilling the hole and remains near the platform, they don't flee.

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	Normally the impacts of seismic surveys on fishing are bigger because the fishermen are prevented from fishing in an area due to the movement of the vessel but the platform is fixed and the fishermen can fish as they wish, outside the exclusion zone of a minimum of 500 metres for the security of the fishermen and their fishing activities. The environmental study that is presented here today refers to the drilling project and does not include the seismic survey. The environmental study for the seismic component has already been done and is a separate project.
	Regarding communication, the communication teams will be in the field before the arrival of the platform. We will not wait for the arrival of the platform to transmit information to the local population. We don't know yet how the Communication Plan will be designed for this specific project but we normally have a base and a liaison officer for the communities in each affected area. There will also be a liaison officer for fishing who will be based aboard the support vessel that will circulate around the platform. Thus, there is a very extensive mechanism to try to communicate, but always beforehand, about the position of the platform. In the case of the seismic survey the communication has different phases due to the movement of the seismic vessel to guarantee that the fishermen know where the exploration is being done. But in the case of drilling, information is normally transmitted before the arrival of the platform, its coordinates are given, the number of days during which it will remain at the same spot and the exclusion zone. Thus, there is a small difference between the implementation of the communication for seismic survey and for the drilling of exploration wells. But we will guarantee that the information will reach the communities before the start of the project.
Luís dos Santos Namanha, Director of the Bazaruto Archipelago National Park	Comment registered. See response above.

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We expect that in this second phase of the exploration the communication will be wider.	
Victor José António, Provincial Directorate of Mineral Resources and Energy In the southern part of Sofala Province there is the Buzi Hydrocarbon company that will do hydrocarbon exploration on land. Now we also have Sasol doing exploration in the same offshore area and we have two common elements, namely the community and the coastal area. We know that they are different companies but I would like to see coordination in the preparation of communication and compensation plans for the activities of the land and offshore companies, because in subsequent phases in which there was a single company there were complications with the communities. Thus, if the two companies have different communication and compensation plans, the situation will become much more complicated.	Suggestion accepted and registered.
Afonsina Fernandes, Provincial Directorate for the Coordination of Environmental Affairs I suggest that the Communication Plan should not only cover the implementation period of the activity but also the period before implementation to allow that the communities can understand what will occur and what is occurring.	Normally, at least a month before the start of the operations Sasol starts the communication and information process for the communities and fishing associations, paying field visits with explanatory pamphlets in local languages, with a photograph of the platform, explaining about the platform, the support vessel, the exclusion zone, etc. Communication is one of Sasol's basic concerns. In addition to the pamphlets Sasol also works with the community radios and with the provincial broadcasting station of the respective provinces, the Provincial Broadcasting Station of Inhambane and the Provincial Station of Sofala, including Radio Maria. However, because of the compensation team, this communication will continue for another month after the conclusion of the project, so that in the case of any claim we are sure that the issue is closed.
	According to Sasol's experience with previous projects the Communication Plan not only applies to the drilling period but

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	starts before the beginning and continues after of conclusion of the project. The drilling sites have not yet been selected. The communication programme can only start when we know the drilling sites because the communication teams can then provide exact information about the vessel's position. The communication plan will occur before, during and after the drilling activities but at this moment we cannot do much more because the drilling sites have not yet been defined. In exploration it is not possible to decide today that drilling will be done tomorrow. A lot of time is necessary to order the equipment, request the platform and bring it here. Thus, when we identify the site where we want to drill we will need about nine months to order the equipment and do a preliminary exploration in the area. Thus, all this time allows the implementation of communication.
Afonsina Fernandes, Provincial Directorate for the Coordination of Environmental Affairs We are in the EPDA preparation phase and the EPDA will reflect what will be the Environmental Impact Study. Thus, all important aspects should be mentioned in the EPDA to be reflected in the EIA. Thus, the Communication Plan should be designed in this phase so that it can be reflected in the EIA.	We agree with your comment. The only thing that cannot be dealt with is when the Communication Plan will be implemented, and also very detailed aspects of the contents of the plan, though in this phase it is possible to lay down already the general principles.
Eduardo Vicente, Provincial Directorate of Fisheries I would like to insist again on the issue of communication, taking as example the 16 and 19 blocks. Sasol knows that there were claims in 2007 for fictitious compensations because no preliminary and coordinated work was done due to lack of communication. At the time, when things became very complicated, we had to suggest how they should be dealt with. In fact, communication is the key factor	Thank you very much. Your suggestions and recommendations are noted and will be considered. A list of consultants and studies that will be done was presented but the consultants will not work without the institutions, as it is through these that we will collect the information to be included into the report. As for example Mr. Atanásio Brito, who works for fisheries, is our fisheries specialist and has worked a lot in the Sofala Bank area and has a lot of information about the area. Thus, we bring together consultants

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of this work. If we fail to communicate we are liable to compensate people. The communities and the districts should be involved to avoid opportunism and compensation claims. The involvement of all these should be done well before the start of the studies and of the project, as is the case of the IDPPE, which deals with the fishermen and which should be informed to start doing its work. At district level we have the District Services of Economic Activities, of which fisheries is part, as well as the small units which are the community fishing centres and the fishing associations. The Census taken by the IDPPE should be used as a basis since it has data about the number of fishermen and fishing boats existing in each district, though they are a little outdated because fishermen are migratory. The Census has data at district, provincial and national level.	who will do the work but they get information from the various institutions at central, provincial, district and local level. The involvement of the institutions is done at several levels, through the public consultation meetings and through direct contacts carried out by specialists who are working in the field.
Manuel Castigo, Secretary of the Govuro Fishermen Association I thank the Director of Fisheries for his intervention because he was able to transmit our concerns. As fisherman I declare and testify that in this area some boats were lost because they went to the Platform to receive compensation. Machanga and Nova Mambone have accumulated experience in the area of communication and compensation.	Comment registered.
Public Participation Process	
Afonsina Fernandes, Provincial Directorate for the Coordination of Environmental Affairs I suggest that in the next public consultation the DPCA is involved to send the report to some institutions existing in Inhambane Province so that they can give contributions about the study area. The Centre for Sustainable Development in Xai-Xai, whose field of activity is the entire coastal area from the Rovuma to Maputo, should also be involved.	The Centre for Sustainable Development was invited to participate in the meeting in Maputo. It was not possible to send the documents in advance to the key institutions as there was a delay in the submission of the Executive Summaries and to guarantee their delivery they will be sent to the provincial directorates and district administrations after the meeting; we brought a few copies to this meeting. They will be handed over to a few key institutions. We will also reserve a two-week period so that comments to the report can be made. In future we will improve coordination.

ISSUES	RESPONSES
Afonsina Fernandes, Provincial Directorate for the Coordination of Environmental Affairs I suggest that before the meetings there is coordination with the DPCA regarding the identification of the interested and affected parties of the project, since our Directorate can give its contribution with a few institutions that work directly or indirectly with us in the assessment and review of studies so that they will also participate in the meetings and in the public consultation process.	Comment registered and will be taken into consideration.
Environmental Impact Study	
Eduardo Vicente, Provincial Directorate of Fisheries It is important to involve all institutions that are related to the project during the environmental study. In the case of fisheries the Fisheries Research Institute, the Small-Scale Fisheries Development Institute (IDPPE), INAQUA, the aquaculture companies, and others, should be involved.	Thank you for the suggestion.
Jamilo Amade, Small-Scale Fisheries Development Institute I have a question regarding what was said about the distance and depth of the M-10 block, because it was said that there are no artisanal fishermen in this block. Currently, the Ministry of Fisheries is encouraging the fishermen to fish offshore. What we have observed is that of late many artisanal fishermen have a tendency to fish further away until a depth of 20 metres and they have acquired boats of greater capacity.	When it was said that there is nobody in the M-10 block, this referred to the existence of inhabited islands and the absence of tourism. It was not said that there were no fishermen, since the map we showed indicates the existence in the area of a zone of industrial and semi-industrial prawn fishing, deep-sea prawn fishing in very deep zones and an industrial prawn fishing zone. Thus, we are aware that there are different types of artisanal fishing (line fishing, with the use of ice, etc.) in our study area. The measures will be taken carefully, so that the impacts are minimized, so as to avoid affecting the fishermen's activities in this area. It is therefore important to know what exists and which activities are being carried out in our study area, precisely so that we can know how they can be affected and how we can reduce the impact on these activities. From our preliminary studies we already know that there are many fishermen in the area and that Búzi and Machanga have the largest number of fishing camps.

ISSUES	RESPONSES
Jamilo Amade, Small-Scale Fisheries Development Institute I have a question about the distance and depth of the drilling sites. In the previous exploration, some fishermen sailed to very distant points where they knew that they would find the vessel, reaching depths of 20 metres.	For the Sofala block the minimum distance to the coast is 1 km and for the M-10 block the minimum distance to the coast is 12 km, reaching depths of 20 to 30 metres. Thus, there are certainly fishermen in these areas.

AVALIAÇÃO DE IMPACTO AMBIENTAL DAS ACTIVIDADES DE PERFURAÇÃO DE PESQUISA DE HIDROCARBONETOS NAS CONCESSÕES DE SOFALA E M-10

Convite para Reunião de Apresentação do Rascunho do Relatório do Estudo de Impacto Ambiental

A Sasol Petroleum Sengala Limitada Moçambique e a Sasol Petroleum M-10 Limitada Moçambique, subsidiárias da Sasol Petroleum International ("Sasol"), pretendem realizar Actividades de Perfuração de Pesquisa de Hidrocarbonetos nas Concessões de Sofala e M-10, ao longo da linha costeira das Províncias de Sofala e Inhambane.

A **Impacto, Lda e a Environmental Resources Management (ERM)** encontram-se a realizar a Avaliação de Impacto Ambiental (AIA) dessas actividades. Os Processos de AIA para cada concessão estão a decorrer separadamente mas o Processo de Participação Pública está sendo realizado em simultâneo, cujas primeiras Consultas para a apresentação do rascunho do relatório do Estudo de Pré-viabilidade Ambiental e Definição de Âmbito (EPDA) e Termos de Referência (TdR) do projecto, tiveram lugar em Agosto de 2010 nas Cidades da Beira e de Maputo e no Distrito de Govuro (na Província de Inhambane).

Dando continuidade ao processo de Participação Pública, a Impacto e a ERM vão apresentar o rascunho do **Relatório do Estudo de Impacto Ambiental (EIA)** para apreciação e comentários de todos os interessados, igualmente nas Cidades da Beira e de Maputo e no Distrito de Govuro, nas seguintes datas:

Cidade da Beira	Cidade de Maputo	Distrito de Govuro
Data: 28 de Fevereiro de 2011 Hora: 9-12 horas Local: Hotel Moçambique	Data: 01 de Março de 2011 Hora: 9-12 horas Local: Hotel VIP	Data: 03 de Março de 2011 Hora: 9-12 horas Local: Residencial Mambone

Informa-se que o rascunho do relatório de EIA está disponível para consulta na Internet, em Português e Inglês, no seguinte portal:
http://www.erm.com/sasol_sofala_m10.

A Sasol tem o prazer de convidar todas as partes interessadas e potencialmente afectadas pelo projecto, a participar nas reuniões de consulta pública.

Para esclarecimentos, por favor contactar a Impacto Lda, Att: Sandra Fernandes, através do endereço sfernandes@impacto.co.mz ou pelo Telefone +258 21499636, Fax +258 21493019 ou Telemóvel: +258 82 3046650.

Impacto
Projectos e Estudos Ambientais

ERM

Diário de Moçambique, 28/02/11

AVALIAÇÃO DE IMPACTO AMBIENTAL

DAS ACTIVIDADES DE PERFURAÇÃO DE PESQUISA DE HIDROCARBONETOS NAS CONCESSÕES DE SOFALA E M-10

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